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ABSTRACT

An experimental, undergraduate African-history course which used self-paced instructional techniques is described and evaluated in this project report. The project was initiated to assess the effectiveness of the Personalized System of Instruction (PSI) in undergraduate history instruction. Thirty-two students from Carnegie-Mellon University participated in the experimental course. In the course students moved at their own paces, using written study guides, taking mastery tests at the end of each unit, and meeting with proctors to evaluate their progress. Large group lectures were used for instructional purposes. Content focused on the history of Africa south of the Sahara and on a specific problem-solving strategy as well as selected analytical skills. The findings indicated that the students in the experimental class learned more than the control classes and were more enthusiastic about the instructional technique. The report is divided into two sections. Part 1 includes descriptions of the project, the experimental course, results of the course evaluations, and changes in the experimental version of the course resulting from the course evaluation. Part 2 presents some guidelines for college faculty interested in considering the particular type of self-paced learning used in this project. This section describes the conclusions of the project, analyzes the strengths and weaknesses of the instructional approach, and examines some implications of this form of self-paced instruction for undergraduate history teaching and undergraduate education in general. (Author/DE)

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FINAL REPORT
HISTORY TEACHING PROJECT

U.S. DEPARTMENT OF HEALTH,
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A Project to Improve Productivity in Teaching at Carnegie-Mellon University Through the Development of Self-Paced Instruction in Undergraduate History

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INTRODUCTION

In April 1974, the Carnegie-Mellon University Central Administration awarded a grant of $18,505 to the Department of History and Philosophy to support a project to improve productivity in undergraduate history teaching at the university. This project proposed to design and evaluate via a classroom field test an "independent study, introductory course" in African history in an effort to evaluate the practicalities and effectiveness of self-paced learning in history for Carnegie-Mellon University undergraduates.

In addition to the evaluation of the experimental, self-paced course, the project envisioned two other possible products -- a workable self-paced course of study in history for CMU undergraduates and a set of guidelines for CMU faculty seeking to create similar self-paced courses in their own special fields and departments.

The project began June 1, 1974 and formally concluded on September 2, 1975. However, analysis of the classroom evaluation results, rewriting and typing of revised materials and preparation of a final report were not completed until December 1975.

This report presents in Part I a description of the project which (1) outlines the conduct of the project, (2) describes the experimental course, (3) reports the results of the course evaluations, and (4) describes changes in the experimental version of the course resulting from the course evaluation.

Part II of this report presents some guidelines for college faculty interested in considering for use in their own courses the particular type of self-paced learning used in this project. This part of the report (1) describes the conclusions of this research project, (2) analyzes the strengths and weaknesses of the instructional approach tested here, and (3) examines some implications of this form of self-paced instruction for undergraduate history teaching at CMU and for undergraduate education in general. The report concludes by suggesting directions for future research in self-paced learning and by outlining possible follow-ups to this particular project.

PART I - DEVELOPMENT AND EVALUATION OF A SELF-PACED COURSE IN UNDERGRADUATE HISTORY

A. CONDUCT OF THE PROJECT

Dr. Barry K. Beyer, Associate Professor of History and Director of Graduate Studies in History at Carnegie-Mellon University directed this project as the principal investigator. In order to accomplish its goal, however, the project required the services of a number of scholars, specialists and students over a period of nineteen months beginning in June 1974. This part of the report describes (1) the project objectives, (2) the six basic stages by which the project staff carried out its responsibilities, and (3) the members of the project staff.

Project Objectives

This project sought answers to the following questions:

(1) To what extent is self-paced instruction/learning in history practical for college undergraduates?

(2) To what extent does self-paced learning using a Personalized System of Instruction (P.S.I.) format enhance student learning?

(3) To what extent does self-paced learning in history using a P.S.I. format appeal to college undergraduates?

(4) What are the advantages and disadvantages of P.S.I. for undergraduate history and, by extension, for any course relying heavily on reading and writing?

Procedures and Activities

In order to answer the above questions the project staff designed, taught and evaluated a one-semester introductory course in African history for CMU undergraduates. To accomplish this task, the project staff engaged in six distinct operations: (1) research into potential structures for the course, (2) design of the course and the course materials, (3) development of specific instructional materials and procedures, (4) evaluation of the course via a classroom field trial and by an outside expert, (5) analysis and reporting of the field trial results and of the expert evaluation, and (6) revision of the course in the light of these evaluations.

Research Research into the literature on independent study, audio-visual materials and techniques and self-paced learning occurred during the three summer months beginning in June 1974. During this time professional literature as well as selected educational studies were reviewed (1) to identify or devise an independent study structure most potentially useful for the proposed course and (2) to determine the role most appropriate for audio and visual materials in this course. During this time the staff identified approximately a dozen undergraduate independent-study history courses in operation throughout the United States and secured materials, outlines and descriptions of nine of these for examination. The staff also conducted an intensive search of the relevant professional literature to identify descriptions of and research into all possible forms of independent study. This research resulted in two basic decisions -- first, that the course would be built on the principles of an instructional system known as Personalized System of Instruction and, second, that audio and visual materials would play a less significant role in this course than originally envisioned.[1]

Design The second phase of this project involved designing the overall structures of the course and of the instructional materials and evaluation instruments to be used in the course. The fundamental decisions regarding content to be included, sequence to be followed, the type of problem-solving strategy to be utilized, and the specific skills to be taught were made during September as a result of further research and discussion. In addition, the staff devised a format for the individual study guides that were to constitute the core of instruction for the course and identified specific audio-visual materials for development.

Development Preparation of course materials occupied almost the full-time efforts of the project director and research assistant from October through January. This work required the writing, evaluation and repeated revision of (1) student study guides for each of the twenty units which comprised the course, (2) content and problem-solving evaluation instruments for pre- and post-test purposes, and (3) three slide-tape presentations. Student reading materials were also identified and ordered for use as texts and for deposit in Hunt Library as reserve reading or references. Once materials were judged to be acceptable in terms of scholarship, structure, style and educational utility they were typed, duplicated

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1. See below pp. 19-20

and prepared for distribution. Approximately two-thirds of the course materials were written and duplicated by the beginning of the spring 1975 semester when the course started. The remaining materials were written and duplicated during the early spring with this phase of the project completed at the end of the spring break in April.

Secretaries in the Social Studies Curriculum Center typed several units and evaluation instruments for the project. Most course materials, however, were typed outside the Center by part-time typists employed especially for this purpose. All project materials were duplicated in the Center in quantities sufficient for the field test class and for file sets only.

Classroom Field Test The fourth or field-test phase of the project began in January 1975 with the start of the Spring 1975 semester and continued until the end of the semester in May. The course was offered as 79-390 History of Africa and was described as a regular history course, one section of which would be self-paced. Notices were sent to advisors describing more explicitly the experimental nature of the course.[2/] Thirty-two students eventually enrolled in the course, the largest number of undergraduates ever enrolled in a course in African history at CMU, and twenty-eight of them remained in the course for the duration of the semester. Because of the low enrollment, however, only one section of the course was offered, the experimental self-paced section. This section had faculty and proctors available in a large classroom to meet with students a total of six hours weekly at a regularly scheduled time

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2. See Appendix A for course descriptions circulated during registration for Spring 1975 courses.

of 2:30-4:30 Mondays, Wednesdays and Fridays. Students were free to attend class at any time they chose within these given times to study, to secure help from a proctor or instructor, to take tests, to use a slide-tape presentation or merely to talk informally about the course. The final tests were first taken April 2 and periodically thereafter as students completed the course units. Class sessions continued to be held through Friday, May 9 in order to offer all students an opportunity to complete the course before leaving for their summer vacations.[3]

This phase of the project also involved special periodic meetings of the instructors with the three course proctors. The proctors were familiar with neither P.S.I. nor African history at the start of the course. Thus, the instructors conducted periodic meetings with them to tutor them through the course units in advance of their students and to discuss various aspects of African history with them, according to their interests. Other periodic meetings were conducted to evaluate materials used in the course, to evaluate student progress and to explore possible on-going revisions in the course.

Evaluation Data on which to evaluate the course was collected prior to, during and at the end of the course using instruments designed especially for this project.[4] Additional data regarding the strengths and weaknesses of each unit and of the

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3. See Appendix B for a detailed description of the course procedures.

4. Specific data regarding these evaluations will be found on pp. 22-64.

instructional materials used in the course were collected during the course by the instructors from the students and proctors. These data were analyzed during the Fall 1975 semester. An outside evaluator also critiqued the course materials in order to evaluate the extent to which they met the P.S.I. format.

Revision The sixth and final step in the process of developing this course involved revising the course structure and materials in light of the field trial experience and results. This work was carried on by Beyer and O'Toole during the summer months of 1975 and was completed in October 1975. Numerous revisions, deletions and additions were made to the course structure and materials during this intense review. New materials were then typed in the Social Studies Curriculum Center and by outside typists and duplicated so they would be ready for use when the course is next offered.[5] This final report was then prepared for submission upon completion of the project.

Project Staff

Five types of personnel participated in this project. Research design, development and instruction were primarily the responsibilities of Project Director Barry K. Beyer and Mr. Thomas O'Toole, Assistant Professor of History at Western Carolina University (Cullowee, North Carolina) on leave at CMU to complete his doctorate in history. Professor Beyer was formerly Director of Project Africa, a major USOE-funded secondary school curriculum development project at CMU and is a nationally recognized authority on teaching about

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5. While the initial university grant funded all phases of this project, typing and duplication of the revised course materials was made possible by a supplementary grant in the spring of 1975 from the College of Humanities and Social Sciences.

Africa. Professor O'Toole has travelled extensively in West Africa, has co-produced a series of films on African history for the University of Minnesota and has published several books, articles and an encyclopedia article on African history and cultures. Professors Beyer and O'Toole served as the central staff of the project, researching, designing and writing the entire course and all instructional and evaluative materials used in the course and serving as course instructors during the classroom tryout of the course.

Two consultants provided special expertise for this project. Dr. Maurice Nduanya, on leave at the University of Pittsburgh from his position on the faculty of the University of Nigeria, Nsukka, served as an advisor in the areas of African history and curriculum development. A professional historian trained in curriculum development, Dr. Nduanya designed two of the instructional units in the course, critiqued the others, and reviewed the initial evaluation instruments. Dr. William Leaf, Assistant Professor of Psychology at CMU, served as chief evaluator of the project overseeing the selection and preparation of evaluation instruments, planning the final research design and analyzing and reporting the evaluation data.

Three proctors comprised part of the instructional team that "taught" the project's course in the classroom field trial. Ronald Zarychta, completing his doctoral research in history at CMU, served as course manager as well as a proctor. Lawrence Rivers, engaged in coursework for his history doctorate at CMU, and John McGuire, a senior history major at CMU, also served as course proctors. As proctors each assumed primary responsibility for testing, "tutoring" and assisting ten or eleven undergraduate students in the course.

All three not only did an outstanding job in the instructional phase of the project but also made important criticisms and suggestions throughout the later development stages as well.

A number of other college faculty also contributed to this project. Professors William Cohn and Roland Smith of the CMU Department of History and Philosophy provided informal suggestions and ideas. Professor Richard Hayes of the Department of Psychology assisted in setting up the original research design. Professor Ben A. Green, Jr., of the Center for Personalized Instruction at Georgetown University, prepared an evaluation of the course designed by the project. Advice was also provided by a quartet of professors experienced in the development of self-paced instruction at the undergraduate level: Professors Stanley Charap and Charles Goodspeed of Carnegie Institute of Technology, CMU; Professor J. Gilmour Sherman of the Center for Personalized Instruction at Georgetown University; and Professor Billy V. Koen of the University of Texas at Austin.

Finally, the thirty-two undergraduates enrolled in the experimental version of the course also contributed to the development of the project. Not only did their perceived knowledge and skills shape the content and structure of the course, but their voluntary feedback during the teaching of the course provided additional data useful in shaping the final segments of the course and in making revisions for later use.

This project thus received a great deal of input from a variety of scholars, educators and students. To a great extent its products reflect the combined efforts, ideas and suggestions of a large number of individuals as distilled and developed by Professors Beyer and O'Toole.

B. THE EXPERIMENTAL COURSE

The primary vehicle for this research was an introductory course in African history for undergraduates at CMU. As outlined in the proposal the course was to have three distinguishing features: (1) it would use a variety of audio, visual and written learning materials; (2) study guides and semi-programmed materials would be used to accomplish specific learning objectives; and (3) the course would introduce students to a problem-solving strategy.

The initial decision to create a self-paced course in African history resulted from consideration of several factors. First, African history was the area of special interest and specialization of Professor Barry Beyer, the principal investigator, and of research assistant, Thomas O'Toole. Both instructors had previously taught college-level introductory courses in African history. Development of a self-paced course using content with which the developers were already quite familiar seemed to offer an opportunity to concentrate on the mechanics of casting this content in a self-paced, independent-study format and evaluating the results. By so doing, the developers could thus avoid all the problems of attempting to design a course in which both the content and structure were unfamiliar to them.

Additional considerations also led to the decision to focus the course on African history. Since an introductory course in African history had not been offered by the university for some time, it was felt that this new offering would attract a reasonable number of students, enough to offer both an experimental section and a conventionally-taught control group. Finally, experts in educational innovation suggest that experimental courses of the type proposed by the project limit enrollment to a manageable level of 20-30 students, and a course about African history seemed reasonably possible within these limits.[6] Thus, the decision was made in submitting the proposal to the university to focus the proposed independent-study course on the history of Africa.

Content Structure

The experimental course, as developed by the project, had both a content and a methodological structure. In terms of content, the course served as an introduction to the history of Africa south of the Sahara that attempted to accomplish three goals. First, the course emphasized a study of selected major events and themes in the history of the people of sub-Saharan Africa from the origins of humankind through the periods of state formation, the rise of trade and commerce, and the period of European colonization to independence and the post-independence present. Within this content structure, the course introduced and developed a specific problem-solving strategy as well as selected analytical skills relevant to the use of this strategy in historical study. Finally, the course utilized materials, activities and questions designed to help students get inside the subject and view African history from an African point of view.

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6. Ben A. Green, Jr., "Fifteen Reasons Not to Use the Keller Plan," in J. Gilmour Sherman, P.S.I. - Personalized System of Instruction: 41 Germinal Papers (Menlo Park: W. A. Benjamin, Inc., 1974) p. 118.

The content structure of this course was devised by Professors Beyer and O'Toole. Factors such as the structures of already existing courses, the organization of the text selected for the course, the objectives specified for the course, predicted student knowledge of the course content, and the nature of the discipline of African history helped shape the final structure of this course.

Methodological Structure

The P.S.I. Method This course represented an attempt to employ a system of instruction known as a Personalized System of Instruction (P.S.I.) as developed by Professors Fred Keller, J. Gilmour Sherman and others over the past decade. This instructional system theoretically has five distinguishing characteristics:

(1) Courses are divided into specific units, directions for the study of which are provided by written instructions in the form of Study Guides:

(2) Students move from one unit to the next only when they have demonstrated mastery of a given unit on a unit test; they may repeat unit tests as frequently as necessary to master the objectives of a unit;

(3) Students move through the units at their own rates of speed;

(4) Large group lectures or demonstrations serve primarily as vehicles for motivation and enrichment rather than as sources of tested information; and

(5) Proctors provide students with immediate test scoring and feedback, some individual tutoring and personal support.

In essence, P.S.I. holds quality constant (all those who complete the course by mastering each component get a high grade) while varying the time it takes students to complete the course. Conventional courses, on the other hand, vary quality (by giving a wide range of grades) while holding constant the time it takes to complete the course.

In its original form, P.S.I. reflects a number of principles derived from behavioristic psychology and reinforcement learning theory. The material to be learned is presented in small "bite-sized" chunks; students are provided immediate feedback; and reinforcement is frequent and positive -- there is no recorded penalty for failure to master a unit. In addition, instruction is highly personalized. This approach also provides a number of motivators over and above any internal student desire to learn the subject of the course. The opportunity to get a high grade and the fact that the course is self-paced and not dependent on a fixed time schedule of lectures or classes serve as two motivators inherent in this instructional approach.[7]

The P.S.I. instructional format used in this course appeared to offer the best vehicle available for accomplishing the major objectives of the research project for three reasons. First, a well-defined body of literature describing courses built on this instructional system already exists and provides useful guidance in the design of such courses. Second, there is also considerable published research, although of varying quality, which suggests that of all instructional systems (lecture, lecture-discussion, discussion, seminar, etc.)

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7. See, for example, Fred S. Keller, "Goodbye Teacher," in Sherman, 41 Germinal Papers, pp. 7-8.

P.S.I. is the only one that makes a significant difference in learning -- students in P.S.I. courses, when compared to students taking the same subject via a more conventional instructional approach, learn more information or skills, retain what they learn longer, and do better (as measured by test scores) in subsequent courses whether these courses be conventional or P.S.I.[8] Third, the P.S.I. format or recognizable adaptations thereof, are already used in undergraduate instruction at CMU -- especially in engineering, chemistry and math. Since many engineering, math and science students also take courses in history, the availability of P.S.I. courses in history could provide an instructional continuity across colleges in CMU that might facilitate learning for these students and encourage them to take additional history courses in future semesters.

Probably the most important reason for selecting P.S.I as the basic instructional mode for this project, however, was the potential such an effort offered for making a unique contribution to undergraduate education in history at CMU and throughout the nation. At the time this project was conducted P.S.I. was not used at all in the College of Humanities and Social Sciences nor was it employed in any recognizable form in more than two or three history courses that could be located anywhere in the nation. Thus, an effort to design a history course based as faithfully as possible on the basic principles of the Personalized System of Instruction seemed to be a most worthwhile research effort. Such an effort offered an opportunity

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8. James Kulik, P.S.I.: A Formative Evaluation (unpublished invited address at the National Conference on Personalized Instruction in Higher Education, Los Angeles, March 1975).

to test this instructional approach in a heretofore "neglected discipline" as far as the application of P.S.I. is concerned and an opportunity to improve learning and hence teaching productivity in the undergraduate history program at Carnegie-Mellon University. Results of this research could also have significant implications for undergraduate history teaching in institutions of higher education throughout the United States.

Course Components In order to create a P.S.I. course in African history faithfully adhering to the basic principles of P.S.I., the project staff found it necessary to develop four types of student materials -- student study guides, unit tests, filmstrip-tape presentations, and evaluation instruments as well as a set of lecture-demonstrations.[9]

Twenty student Study Guides were developed, one for each unit in the course, to guide students at their own pace through the course. Although the guides varied in length and complexity, the typical guide consisted of 12-15 pages of instructor comments, learning objectives, questions, student assignments and self-testing activities. With the exception of the first unit, which was a brief introductory unit requiring only thirty minutes to complete, each unit study guide was broken into parts called modules which, in effect, were simply short study guides in themselves devoted to a single aspect of the unit. Each of these nineteen study guides followed this format:

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9. See Appendix B. This course description outlines the features of the course in terms of the basic features of P.S.I.

(1) Introduction to the Unit -- a statement of the purpose of the unit establishing a link to preceding and following units and providing essential data not found in the assigned materials.

(2) Unit objectives -- stated in terms of observable student behaviors or products of student behavior.

(3) Modules -- smaller "units" of study built around specific aspects of the general unit topic, with each module structured as follows:

  a) Introduction to the student
  b) Learning objectives
  c) List of materials to be used
  d) Directions for study — usually built around a series of questions designed to help students accomplish the module objectives
  e) A Self-Check activity consisting usually of a 10-15 item objective (multiple choice and completion) and essay test but sometimes involving an interview with another student or proctor.
  f) Suggestions for review in instances where the Self-Check revealed gaps or inadequacies

(4) Directions for a unit mastery test.

(5) An answer key for the module self-checks.

It was intended that each module, built as it was around a specific reading, writing or viewing assignment, require approximately two hours of student time. Since the twenty units consisted of an average of three modules each, the total course thus required an estimated 120 hours of student time -- the equivalent of any other nine unit (three semester credit hour) university course.[10]

The study guides were intended for use by the students individually. Small or large group learning activities were deliberately omitted from these materials. Omission of these group activities was implicit in the decision to adhere as closely as possible to the basic format of P.S.I.-structured courses. As a system of individual instruction stressing individual mastery and self-pacing, P.S.I. seems to emphasize a personalized, one-to-one interaction between instructor/proctor and student rather than student-student interaction in groups of any sort. In order to keep this course a P.S.I. course, group activities were thus deliberately eliminated. This is not to say group learning did not occur, however. Students frequently worked in pairs to complete study guides, especially in the early stages of the course when many were at about the same place and could conveniently work together. Not infrequently did students volunteer to assist one another; this was especially true of students who had just finished a slide-tape and wanted to assist others in "going through" the same material.

Three unit mastery tests accompanied each of eighteen units in the course. The first unit included only two such tests and the final unit ended with a two-hour final exam. The 56 unit tests usually

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10. See Appendix C for copies of a representative study guide.

consisted of 10-20 objective items and one or two short essays designed to measure student accomplishment of the objectives specified in the unit study guides. All forms of a test for a given unit were comparable to each other and attempted to sample adequately the unit objectives.[11] In accord with the basic P.S.I. approach students were required to achieve correct responses on at least 85% of a unit mastery test in order to proceed to the next unit.[12]

In addition to the study guides and associated unit mastery tests, the course also utilized a number of audio-visual materials prepared by the project. The initial project proposal called for a significant emphasis on these materials in the course, but only a limited number were developed. Lack of suitable permanent viewing and listening facilities, the extremely high cost of renting equipment from Teaching Aids, and the difficulty of obtaining appropriate equipment when needed made it necessary to limit the use of audio-visual media. The necessity of reallocating project funds to cover unanticipated expenses for materials, typing and equipment rental made this decision even more imperative.

Nevertheless, the project staff developed three special slide-tape programs and adapted a fourth commercially-prepared program for the course.[13] These materials were written and designed by the course instructors, using slides from Professor Beyer's collection of materials on Africa and from university sources. Recordings were made by the project staff using the equipment and the facilities of the Social Studies Curriculum Center. Although no recorded lectures were produced by the project, mini-lectures were incorporated as short essays in the student study guides.

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[11] See Appendix D for copies of a set of tests for a typical unit.

[12] Research indicates no significant difference in final exam scores between students achieving 80% mastery on unit tests and those meeting higher standards of mastery on unit tests. See James Block, ed., Mastery Learning: Theory and Practice (New York: Holt, Rinehart and Winston, Inc., 1971), p. 70.

[13] See Appendix E for the slide-tape scripts and outlines.

The fourth type of material prepared for use in this course consisted of a final examination which constituted the final unit of the course. The instructors designed four forms of a 55-item objective test in African history and one-form of a 40 item objective test designed to measure selected problem-solving skills. One of the forms of the African history test was administered to all students in the field test of the course as a pre-test.[14] The other three forms -- with several essay questions added -- were randomly administered as end-of-course final exams since students (because of the self-paced nature of the course) were able to complete the final unit whenever they were ready to do so. The problem-solving skills test served both pre- and post-test purposes. While the content tests were designed especially for the course using a model developed and tested by Professor Beyer during an earlier curriculum project, the problem-solving test was a revision of the Carnegie-Mellon Test For Social Studies Inquiry Skills developed by the CMU Social Studies Curriculum Center in the late 1960's.[15] These instruments were integral parts

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14. See Appendix F for a copy of Form A of this test.

15. See Appendix G for a copy of the revised test.

of the materials developed for this course; that they were able to serve as useful tools in evaluating the efficacy of the course greatly added to their utility in this project.[16]

The instructors also planned three large group lecture-demonstrations.[17] In keeping with the principles of P.S.I., attendance at these lectures was optional and restricted only to those students who had reached a specific unit of the course. The lectures involved viewing and discussing selected films on Africa, mini-lectures by the course instructors and an in-depth African experience built around an authentic, typical African meal.

Thus, the project staff developed an introductory course in African history for CMU undergraduates that deliberately attempted to employ the basic characteristics of the Personalized System of Instruction. Such a course appeared to offer an excellent vehicle for investigating (1) the degree to which P.S.I. would work as a system for teaching undergraduate history and (2) the implications of self-paced instruction for humanities and social science education for Carnegie-Mellon in particular and for these fields in other similar institutions of higher education throughout the nation.

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16. In addition to the above mentioned tests, additional instruments were designed to serve course evaluation purposes exclusively. A unit evaluation form was prepared to elicit student reactions to and suggestions for improving each unit study guide in the course. A detailed course evaluation questionnaire was prepared to measure student reactions to the course. Further reference to both instruments will be found on pp. 22-64.

17. See Appendix E for an outline of these lectures.

C. FIELD TRIAL AND EVALUATION

The experimental course designed by this project was offered for the first time as part of the regular undergraduate curriculum of the College of Humanities and Social Sciences of Carnegie-Mellon University during the Spring 1975 semester. This course was formally evaluated in two ways. First, a recognized specialist in the Personalized System of Instruction approach to self-paced learning evaluated the course materials to determine the extent to which the course met the criteria of self-paced instruction in general and the basic features of the Personalized System of Instruction in particular. Second, a number of specially designed evaluation instruments were used in order to determine the extent to which the course accomplished its prescribed objectives. This section of the report describes and analyzes the results of these two evaluations of this course.

Expert Evaluation

A primary goal of this project was the development of a self-paced course built on the basic principles of a Personalized System of Instruction. In order to evaluate the extent to which the experimental course met the criteria of the P.S.I. mode of instruction, the course materials were submitted to Dr. Ben A. Green, Jr., Associate Director of the Center for Personalized Instruction at Georgetown University and a nationally recognized expert in P.S.I.-based, self-paced instruction.

Dr. Green reviewed the course materials, course structure and course policies.[18] He found the course generally consistent with the basic principles of P.S.I. and the materials appropriate to such a course. The study guide he appraised as "impressive," thorough and imaginative. The introductions, procedures and directions included in each guide he felt were well-designed and quite functional. The self-tests, too, he appraised as most useful. In general, he evaluated the basic components of the course as appropriate to P.S.I.

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[18] See Appendix I for a summary of Professor Green's evaluation.

However, Green questionned the utility and quality of two basic features of the course materials. The emphasis on multiple choice items on self-checks and unit tests he found too heavy. He also noted a disparity between stated learning objectives and the corresponding test items in a number of units. His comments on these points were most instructive:

> There seems to be no clear reason for such a heavy reliance on multiple-choice test questions. Occasionally, multiple-choice questions are needed in order to limit and define the categories the student is to discriminate. They are very objective, too, and easy to grade, but I would say that objectivity (reliability) isn't so important in P.S.I. as it is in courses without proctors. Proctors can evaluate written answers of some length. (there are some essay questions in the tests, but they are relatively rare.) Many of the multiple-choice items can be answered without knowledge of the subject. In some of the early units, at least, the longest answer is right more often than would be expected.
>
> Another criticism concerns the match between objectives and test items. History is a notoriously difficult subject in which to state precise objectives. It is especially difficult, moreover, to test high-level objectives with multiple-choice items. It is possible, but not easy (and, I think, not worth the trouble in P.S.I. courses). The items in this course are often very good, but not consistently so. In Unit V, Module 1, the test questions concern views expressed by Messrs. Clark, July and Leakey, yet the objectives of neither the unit nor the module mention any of these except

> for an objective "to state Dr. Leakey's frame of reference." In practice this discordance may not be serious, since the student has the self-test and will quickly see what the real objectives are. But he will probably conclude that the objectives need not be taken seriously, and the effort spent writing the objectives will have been wasted.

Green found most of the course policies as described to the students in the course policy statement consistent with the requirements of a practical, self-paced instructional course. The lecture arrangements, the description of the course personnel, the description of the course features he rated as good. However, he questionned the desirability of mentioning in the policy statement the possibility of allowing students to take more than a semester to complete the course; instead, he recommended keeping such a possibility tacit as it is in most conventional courses. Green also suggested, in discussing the classtime arrangements, that:

> It might be better to phrase the attendance requirements to suggest more strongly that students are expected to attend class periods frequently, but they don't have to stay for two hours if they finish their work earlier. Let them discover for themselves that occasional absences are not disastrous. By then they will be hooked on the thrill of good progress.

Green also raised questions about the grading policy used in the course:

> The grade policy seems to have a very sharp gradient at the end. Missing only one unit costs a whole grade point regardless of the final exam score. Also the statement is incomplete; what about scores of less than 80 on the final? The usual solution to this problem is a point system: So many points per unit (all or none) and so many for the final (percentage of a stated maximum). Incidentally, this permits giving a small bonus in points for units done on time.

Finally, Green noted that while a review by an expert is one useful way to evaluate an initial effort at a P.S.I. course, the best evaluations of course materials result from student use of these materials. "Expert opinion," he wrote, "is just not worth very much on this point in my opinion, unless you allow that the expert on actually doing the learning is the student, not the reviewer." The best method of determining the utility of any course materials still seems to be using the materials and empirically measuring the results. Hence, the second type of formal course evaluation of the experimental course involves the use of the course materials in an actual classroom situation.

Classroom Field Trial

Although the actual classroom evaluation of this self-paced course was rather broad in nature, it sought to answer three basic questions:

(1) To what extent can a P.S.I.-based, self-paced course effectively teach knowledge of facts, generalizations and concepts in African history?

(2) To what extent can a P.S.I.-based, self-paced course effectively teach selected problem-solving skills in the context of a specific problem-solving mode?

(3) To what extent will students respond favorably to a P.S.I.-based, self-paced introductory course in history -- in this case, in African history?

Experimental Design and Procedures

Guiding Principles The evaluation of this course reflects three basic principles which provide as nearly complete and unbiased data as possible. First, control groups were used in order to provide some basis of comparison for student achievement in the experimental course. Originally, the research design called for a separate class of students comparable to those in the experimental course to take the same course via a conventional lecture-discussion format. However, only a relatively small number of students finally elected to take African history during the Spring semester. The decision was therefore made to include all of these students in the experimental course in order to have a sample large enough to provide as meaningful data as possible. To compensate for this change the project then secured as control groups several classes in other introductory history courses studying subject matter other than African history and consisting of students thought to be similar to those in the experimental course.

The second basic principle underlying this design involved objective measurement and analysis of data. The bulk of the analysis reported here is based on objective performance data from the students in the control and experimental classes and on attitudinal information measured in concrete contexts. Not only can more comprehensive results be obtained from such a procedure, but the effects of evaluator or student biases are minimized by objective, explicit measurement and analysis.

Finally, this evaluation is based on complete premeasures on students enrolled in both the experimental and control classes.

Thus, differential effects of performance between classes and individuals can be separated into learning and pre-knowledge components to better isolate the effects of the self-paced experimental course.

Controls Two sections of the freshman introductory history course, History 79-101 History of Western Civilization, were selected as control groups for this field trial. The course is an introductory one-semester survey of the history of Western European civilization. It is a university-wide service course, taken by almost all students at CMU in their first year of school.

The students in the two sections were from basically two populations: Carnegie Institute of Technology (CIT) freshmen engineering majors and freshmen from the College of Fine Arts (CFA). They represent two distinctly different groups of students at CMU, both in their background and interests and in the form of instruction they typically receive. CIT students often have large lecture classes and technical subject matter; they also are more likely to have had experience in P.S.I. courses in their engineering curriculum. CFA students have less formal classes which emphasize individual contribution and interaction between student and instructor, but they are quite unlikely to have had P.S.I. courses previously. Neither of these two classes matched the experimental sample well, but the two control classes covered a wide range of attributes and values which did bracket well the characteristics of the experimental class.

Experimental Class Thirty-two students enrolled in the experimental course in January 1975. Twenty-six of these students were freshmen while two came from each of the other three undergraduate classes in the university. Twelve of the students elected to take this course; for the other students the course was one of a class of courses from which students were required to sample. Twelve students in the experimental course were enrolled in the College of Humanities and Social Science, eight in CIT, seven in CFA and five in the Mellon Institute of Science at CMU. Of the total thirty-two students that started the course, all but four stuck with the course, 24 completing the course by the end of the semester and four electing to complete it over the summer or during a later semester.

The racial composition of the students in the experimental class was unique for CMU. Seventeen of the total thirty-two students enrolled were blacks. However, there was only one black student in the two control classes. Thus race may be an important uncontrolled variable in this study, not for itself but for two covaried factors. The subject matter in the African history course may have been more attractive and hence more motivating to black students. Also, many blacks (and almost no whites) were students in the Carnegie-Mellon Action Program (C-MAP). C-MAP admits many students from inner-city neighborhoods who have good potential but usually poor pre-collegiate preparation. These students receive a month-long counseling/academic preparation session before their first semester at CMU, and the C-MAP office maintains extensive counseling and tutoring facilities. C-MAP students do not receive special treatment in the classroom, though; they must -- and do -- perform at a level deemed acceptable for the general college population.

Black students are mentioned specifically because they represented a significant portion of the experimental sample, were not well controlled-for, and represented two factors which were likely to affect their performance in the experimental class but which would not affect the performance of non-black students in the same course or students in the control classes. For many of the analyses presented here blacks are analyzed separately in order to make these distinctions. However, it should be noted that differences which might have been expected to develop between black and white performance did not develop -- the performances of black and white students were virtually identical in the experimental course.

Biographical Data For all students in the experimental class and in the two control classes, selected biographical data was collected at the start of the semester.[19] This data is summarized in Table 1. The purpose of the biographical information was twofold: to obtain a picture of the students in the experimental class and to identify similarities and differences between the students in the experimental and control classes.

Table 1 contains separate entries for the two control classes and for black and white students in the experimental class. There were sufficient differences between these four groups (artificially separated in the case of the subgroups of the experimental class) to summarize their data differentially. For example, there were four major differences between blacks and whites in terms of their backgrounds:

(1) The black students were mostly women (14 vs. 3 men in the experimental class while the white students were mostly men (14 vs. 1 woman in the experimental class, 23 vs. 11 in the control classes).

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19. See Appendix J for the form used to collect this data.

TABLE 1. DEMOGRAPHIC DESCRIPTION OF STUDENTS, BY RACE AND CONTROL CLASSES[a]

		Experimental Class		Control Class	
		black	white	Sect. A	Sect. B
Sex:	M	3	14	15	9
	F	14	1	4	7
Class:	Fr	13	13	19	15
	So	2			
	Jr		2		
	Sr	2			1
QPA[b, c]		2.32	2.56	2.80	2.89
College:	CFA	2	5	2	14
	H&SS	3	9		2
	CIT	7	1	15	
	MIS	5		2	
#prior history		1.24	1.37	.42	.77
#prior P.S.I.		.53	.40	.26	0
Why[d] take course?	req.		1	8	8
	1 of req.	3	2	6	2
	req/want	10	4	3	1
	elective	4	8	1	
Political Preference	Liberal	4	5	6	2
	Somewhat Lib	10	7	6	3
	Somewhat Con	2	2	5	6
	Conservative				
Race	White		15	15	15
	Black	17		1	
	Other			3	
Religious Origin	Prot.	9	3	3	6
	Cath.	1	4	12	6
	Jewish		3	1	1
	Other	6	3	2	
	None	1	2		1
Campus Residence	Dorm.	16	11	15	9
	Other	1	3	4	4
Home Background	Urban	15	5	4	5
	Suburban	2	6	8	8
	Rural	0	3	6	3

a. Numbers do not always add to 17, 15, 19 and 16, respectively, since not all students answered all questions.

b. Based on 17, 15, 16, and 14 students respectively.

c. QPA for black students in 79-390 is significantly lower than that for the two control sections ($p < .05$).

d. The "course" is 79-390 or 79-101 for the control subjects; the distribution of answers would not be expected to be similar. Answer choices were:
   --required specifically
   --one of a required group
   --required, but wanted to take
   --elective

(2) Black students had a slightly lower cumulative grade point average (QPA) than did white students at the end of the Spring 1975 semester. The difference (B- vs. C+) was small but statistically significant ($p < .05$).

(3) While about half the white students were from suburban homes, most (15 of 17) blacks listed themselves as coming from urban homes.

(4) Most blacks were raised with protestant or "Other" religious backgrounds; white students showed more balance between those backgrounds and Roman Catholic and Jewish origins.

(5) Black students in the experimental course tended to come from CIT and MIS, the engineering and science colleges of CMU, while their white counterparts came from CFA and H&SS. The two control classes were also separated along this dimension; those from the control class A came primarily from CIT, while those from class B came from CFA.

Students in the experimental class differed from the control students in three important respects:

(1) Students in the experimental class had more prior history courses (1.30) on the average than did students in the control classes (.55).

(2) Experimental group students were more likely to have had prior experience with P.S.I. courses (13 of 32) than were their controls (5 of 30). Even so, though, the experimental class represented the first exposure to P.S.I. for more than half of the students in the course.

(3) Students in the experimental course tended to take the course because of personal desire (30 of 37), while those taking the Western Civilization course usually did so because it was required (24 of 28). This was a valid difference (79-390 was an elective, while 79-101 is a generally required freshman course) but it should have no effect on the results of the study, since performance in the control classes compared with that in 79-390.

Finally, three other factors did not discriminate between groups, but instead served to describe all the students in the study. Almost all students in the three classes were freshmen who lived in dormitories and who tended to be politically liberal.

Course-related measures Between the first and last days of class, several measures were recorded which reflect on the students' prior knowledge, their learning over the semester, and, for the experimental course, their retention and their attitudes toward the course and the subject matter.

(1) A 55-item, objective instrument on the content of the course was administered as a content Pre-test in the experimental and control classes. This instrument was an alternative version of the Final Examination given as a post-test/final exam as described below. Copies of this instrument may be found in Appendix F of this report.

(2) A 40-item, objective Problem-Solving in History test was also administered to all students in this study. This instrument was an adaptation of a test of problem-solving in social studies developed in 1968 at the CMU Social Studies Curriculum Center to test the effectiveness of a new high school social studies curriculum in teaching problem-solving skills. In this context, "problem-solving skills" referred to being able to recognize legitimate, significant historical questions, being able to identify information logically relevant to given hypotheses, being able to evaluate the applicability of data to given statements, and being able to evaluate rationally and integrate the information to answer given questions. The instrument used here is included in Appendix G. Most of the items were taken directly from the earlier test,

a few new ones were added; and several others were modified to eliminate questions requiring knowledge of specific historical content. The test was divided into a series of subtests each designed to measure a distinct skill in the problem-solving strategy reflected in the course. Results on this measure are presented below for the test as a whole and for each subtest.

This instrument was chosen for several reasons. First, it tested the basic skills included in the problem-solving strategy taught in the experimental course. Second, it had been sensitive enough to record positive changes when used in previous studies. Third, commercially available and nationally normed tests, particularly the Watson-Glaser Critical Thinking Appraisal and the Cornell Critical Thinking Test, seemed too easy and only marginally relevant to the subject matter of the course.

This problem-solving instrument proved extremely important to the evaluation of the experimental course. Specific efforts were made in this course to teach a specific problem-solving strategy and its basic skills. Since other courses sometimes purport to teach such skills, it was important to compare the effect of the experimental course on such skills with the effect of other courses which did not make a deliberate attempt to achieve such goals. Furthermore, a criticism of P.S.I. techniques which has retarded their application to history and social sciences and the humanities is that this approach tends to teach facts but not general principles or cognitive styles. This attempt to teach problem-solving skills dealt directly with this perceived weakness, and required careful measurement in order to produce a significant evaluation of this feature of the course.

(3) Progress records of each individual student's rate and success of working through the units of the course also provided additional evaluative data. As noted above the experimental course consisted of 20 units, or segments, each of which had to be passed at a "mastery" level in order to earn an A final grade. The first 19 units covered novel and/or integrative material and were tested by short quizzes administered by the proctors on demand. A performance of 85% or better was required on these quizzes; students who did not achieve this level of performance restudied the unit and took alternative quizzes without penalty until they passed. The final unit in the course was a mandatory final

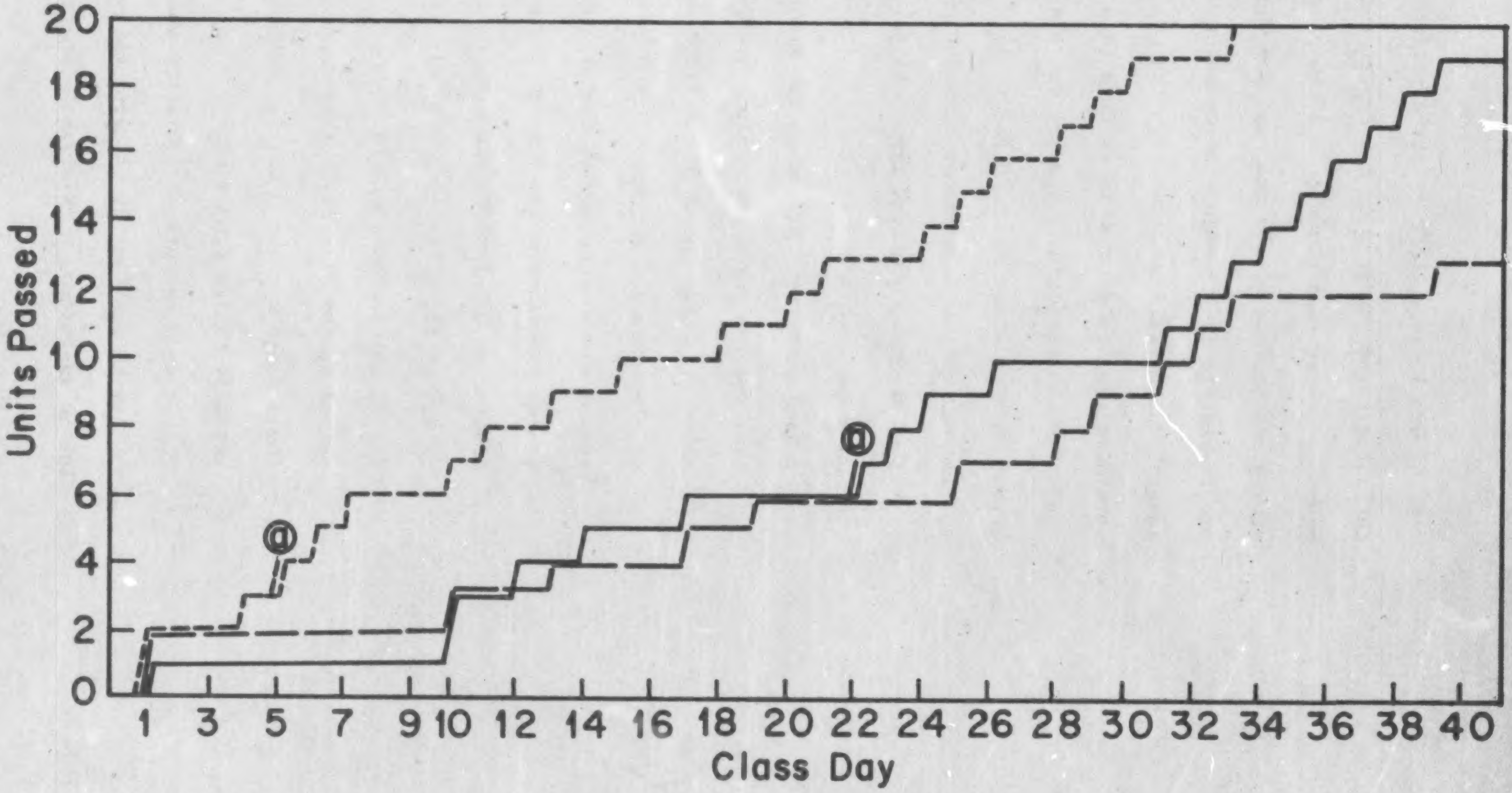
exam, described below, on which a score of 75% was arbitrarily defined as mastery.

Grading in the course was tied strictly to the number of units passed: 20 units = A, 19 = B, 18 = C, 17 = D, and less than 17 = R (failure). (In point of fact, because of the experimental nature of the course, students were permitted to drop the course rather than take an R.) Thus, there was strong incentive to pass all units, but no formal constraints on when during the semester each unit was passed.

With such a system, it is difficult to obtain differential performance measures. Of the 32 students, fully 15 missed no unit quizzes and another 10 missed but one. Thus, error rates were extremely low and likely to be dependent on "noise;" also, at a practical level, error rates did not distinguish in any meaningful way.

The performance measure finally selected was a measure of individual speed in progressing through the course. This was not a totally satisfactory choice, since speed was explicitly described as unimportant to the students. However, as finally measured, it was reliable and did allow some discrimination between meaningfully different groups of students.

FIGURE: 1 THREE CUMULATIVE PERFORMANCE GRAPHS



@ Vertical Lines which Continue from the Bottom Indicate Failed Tests

Figure 1 shows the cumulative performance curve for three students in the experimental course: a very fast student, one who progressed slowly but spurted at the end, and one who progressed slowly and ended the semester with several units still uncompleted. Two measures were developed to attempt to capture in a single number the differences between the curves such as those shown in Figure 1.

a) The sum of the days (class days during the semester, numbered from 1 to 41) on which each unit was passed. (Unpassed units were scored as the maximum, 41.) Scores could range from 20 (if all units were passed on the first day of class) to 820 (if all units were passed on the last day of class); actual scores ranged from 304 for the fastest student to 678 for the slowest.

b) The sum of the units passed by the 21st day of class plus the total number passed by the 31st day. This measure could range between 0 and 40; scores actually varied from 9 to 34.

This second measure is arbitrary and seems insensitive to many subtle patterns which might develop in individual work styles. In practice, however, these problems did not develop. The measure is simple and generated small, convenient, and understandable numbers. Finally, scores for the two measures correlated with r = -.983: they were virtually identical. Thus the second measure of speed was used in the data analysis.

(4) A 55-item, objective Final Exam was taken by the 28 students who had not dropped the experimental course by April. There were three forms of this final. Each contained a different 1/3 of the items from the Content Pretest and 2/3 new items where were designed to be equivalent to the other pretest items.[20] There were no differences between the forms and no indications that the items from the pretest were answered better than the new items on the finals; thus subsequent analyses combine the results from the three forms.

Essay items were also part of the final exams that students took, but scores on this portion of the final are not included in this analysis.

(5) The 40-item objective Problem-Solving in History test used as a pretest was administered again as a post-test. Students were not informed in advance that they would ever take another

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[20] See Appendix K for copies of these instruments.

problem-solving test. They had no hint that, when given, this test was identical to the pretest. As part of the control procedure in the testing of this experimental course the control classes were given the Problem-Solving in History Test as a pretest in January and also as a posttest in April.

(6) Each student in the experimental course also filled out an extensive course/instructor/proctor evaluation form after the final exam and problem-solving post tests had been completed. This instrument is included as Appendix L and is discussed in more detail in the next section.

Results

Final grade distribution Characteristically, in most P.S.I. courses the normal bell-shaped distribution of grades with mostly C and B marks is replaced by a distribution with up to 90% A's. This was the case in the experimental course, as shown in Table 2. In this instance, 53% of the enrolling students received A, 22% received B, and of the remaining 25%, half took incomplete (I) and the other half dropped the course. There were no final grades of C or below.

The high ratios of students who drop the courses before completion also characterizes many P.S.I. courses. The effect is not universal, however, and it seems to depend on course design and management rather than being intrinsic to P.S.I. All four students who dropped this course did so after about six weeks, which was an arbitrary point built into the course for students to verify their interest in continuing. However, their reasons for dropping varied and were little related to this course. One student dropped from school entirely, two others dropped the course because of too much work in their majors (one had three other P.S.I. courses). The final student dropped because he objected to studying in the library.

TABLE 2. FINAL GRADE DISTRIBUTION[a]

	PROCTOR											
	A		B		C		Proctor			Race		
Grade	black/white		black/white		black/white		A	B	C	black/white		Total
A	3	2	3	3	3	3	5	6	6	9	8	17
B	2	1	3	1	0	0	3	4	0	5	2	7
I	0	0	0	0	1	3	0	0	4	1	3	4
(drop)	1	2	1	0	0	0	3	1	0	2	2	4
Total	6	5	7	4	4	6	11	11	10	17	15	32

a. Scores are the number of students at each classification

There were no differences between races in the distribution of grades, with the possible exception of students receiving B and I grades. This seems to have been a feature related to the proctors, however. Each of the three proctors in the experimental course handled quizzes and tutoring for a specific group of students (randomly assigned on the first day of class). All I grades came from one proctor. Subjectively, he was judged by one of the course instructors as being more easygoing; where the other proctors would direct their students into keeping up, proctor C allowed similar lagging students to end the semester without finishing enough units. (Since P.S.I. courses emphasize completing the work in an open-ended time frame, and this course made specific prior provisions for lagging students, this number of I grades is not unreasonable.) Incidentally, all proctors received high positive evaluations by their students; these evaluations are elaborated below.

Performance measures P.S.I. courses tend to frustrate and annoy teachers used to traditional classes and grading schemes: since almost all students receive A's, there is no conventional measure which differentiates between students. P.S.I. proposes that all students who receive A's are equally learned and equally capable of going on. A "traditional" counterargument is that the P.S.I. approach bypasses individual differences through flexible scheduling and various instructional aids; while differences still exist, in learning and in capability, the P.S.I. course ignores them altogether.

This study cannot directly resolve such controversies, although they are significant and need to be answered at some time. Longitudinal measures of retention, ability to apply the learning, and attitude change are required to answer them in this context, and such measures are impossible to obtain within the time constraints of this design. Several measures of performance do exist, however. They are compared in Table 3 for different classifications of students with an *a priori* rationale which might predict differences.

TABLE 3. PERFORMANCE MEASURES OF STUDENTS IN THE EXPERIMENTAL COURSE

	Race of Student				Final Grade				Total	
	black		white		A	B	I	drop		
Measure	avg	(n)	avg	(n)	(n=17)	(n=7)	(n=4)	(n=4)	avg	(n)
Content test:										
Pretest	21.94	(17)	25.4	(15)	26.29*	21.29	20.75	18.75	23.56	(32)
Final	40.57	(14)	43.0	(10)	44.29*	35.0	**	**	41.58	(24)
Improvement	17.21	(14)	16.1	(10)	18.0	13.71	**	**	16.75	(24)
Prob Solv in Hist:										
Pretest	19.59	(17)	21.33	(15)	22.12*	18.14	19.75	17.75	20.41	(32)
Final	26.08	(13)	28.3	(10)	27.24	26.5+	**	**	27.04	(23)
Improvement	5.23	(13)	6.5	(10)	5.12	7.67+	**	**	5.78	(23)
SPEED	21.06	(17)	19.93	(15)	24.65*	19.14	14.5	11.5	20.53	(32)

* scores for "A" students significantly higher than scores for other students $(p < .05)$

** not available

+ n = 6

Black and white students had equivalent scores on all measures. However, there were several significant differences between students with different outcomes from the course, i.e., with different final grades.

Students who ended with B, I, or drop did not differ in prior relevant knowledge as measured by the Content Pretest and the Problem-Solving in History Pretest. But, they did differ in their speed of progressing through the course. This latter finding is almost redundant -- students who dropped had done least in the course, those who received I had done an intermediate amount, and those who completed the course (with B or better) were fastest.

Students who received A, however, were significantly faster than those who received a B final grade. This may indicate that the latter crammed the final units into the last weeks, retained such material less well or were unable to restudy for the final, and thus were less able to do well on the final exam.

"A" students also differed from "B" and other students in their pretest measures. They answered about 5 more of the content questions correctly on the pre-test and about 4 more of the problem-solving questions correctly on the pre-test.

For the content final exam, which tested factual and generalized knowledge, "A" students performed much better than "B" students (44.29 vs. 35.0). In terms of the difference between pre-test and final exam scores, "A" students showed somewhat greater improvement over the semester (18.0 vs. 13.71). The differences did not reach accepted levels of statistical significance, however.

In absolute terms, then, "A" students performed significantly better on a final test of content knowledge, but most of the difference seems to have been related directly to their better background of prior knowledge, although they may also have learned more in the course.

For the problem-solving measures, which tested the development of reasoning skills, there were no significant differences between final scores (27.24 vs. 26.5 for "A" and "B" students, respectively) or in learning (improvement) scores (5.12 vs. 7.67). Although the latter difference was not statistically significant, "B" students improved enough more than "A" students did to almost eliminate the significant advantage held by the "A" students in the pretest.

A factor not included in Table 3 which one might expect to be related to course grade is QPA. It was not. Based on QPA figures which included this course, there were no differences which approached significance. Average QPA values were 2.50, 2.36, 2.25, and 2.46 for students with A, B, I, and drop, respectively.

Table 4 summarizes comparable information for the control groups. Since they were not exposed to the information tested by the content test, only a few students were given the content test as a pretest and posttest measure. Their pretest scores were comparable to the "A" students from the experimental course and higher than the scores of students in the experimental class. The control subjects dropped .5 points on the average between pretest and posttest, suggesting there is little positive carryover into the second testing situation in the conditions governing the taking of these tests.

Twenty-three students from the control groups took the Problem-Solving in History test as a pre-test and again as a post-test. Although their courses did not specifically claim to teach problem-solving skills and strategies, one might expect improvement anyway; whether they exert special effort to teach it or not, most college teachers feel they are teaching reasoning and a mature approach to scholarly investigation.

Such was not the case empirically. Both pretest groups scored as high initially as the experimental course "A" students. They improved only slightly and non-significantly over the semester, though, and significantly less than the experimental course students improved (1.00 vs. 5.78 points, respectively).

TABLE 4. PERFORMANCE MEASURES OF CONTROL STUDENTS

	Section A		Section B		Total	
Measure	avg	(n)	avg	(n)	avg	(n)
Content test:						
Pretest	27.4	(5)			27.4	(5)
Final	27.75	(4)			27.75	(4)
Improvement	- .5	(4)			- .5	(4)
Prob Solv in Hist:						
Pretest	23.92	(12)	22.91	(11)	23.43	(23)
Final	25.5	(12)	23.27	(11)	24.43	(23)
Improvement	1.58	(12)	.36	(11)	1.00	(23)

Table 5 provides a further breakdown of the Problem-Solving in History Test results into subtest scores for experimental and control subjects. Each subtest emphasizes a separate component of the problem-solving method taught in the experimental course.

Improvement from pretest to posttest did not occur for students in either control class on any subtest. For the experimental subjects significant improvement occurred for only the first two subtests. The first required students to match problem-solving terms with their definitions, while the second asked students to select historical questions which can be fruitfully studied from existing types of data.

The remaining subtests, which stressed objective evaluation of data and drawing valid conclusions from that study, showed little improvement through the semester.

TABLE 5. PROBLEM-SOLVING IN HISTORY SUBTEST SCORES

		Experimental Course Final Grade				Control Classes			
		A[a]		B		A[d]		B[e]	
Subtest emphasis	possible points	prtst	pstst	prtst[b]	pstst[c]	prtst	pstst	prtst	pstst
*match term definitions	(10)	4.29	6.41	3.14	5.83	5.25	5.25	4.91	4.82
*select historically fruitful questions	(5)	1.82	3.47	1.57	3.50	2.17	2.92	2.64	2.00
recognize logical consequences	(5)	3.23	3.82	2.86	3.67	3.67	3.67	3.09	3.09
select best data source	(5)	3.29	3.41	1.57	2.83	3.42	3.67	3.18	3.18
evaluate data	(10)	6.82	7.35	6.43	7.33	7.25	7.17	6.73	7.91
test & revise hypothesis based on data	(5)	2.65	2.76	2.57	3.33	2.17	2.58	2.36	2.18

a. n = 17
b. n = 7
c. n = 6
d. n = 12
e. n = 11

*shows significant improvement for 79-390 only.

Thus, students from the experimental course did show improvement in some problem-solving skills as measured by this test while control students, not explicitly exposed to the problem-solving method, did not. However, the significant improvement was limited to only two of the six facets of problem-solving tested. The results are not sufficiently clearcut to show whether students in fact learned the significant processes of problem-solving or whether they only learned peripheral features such as vocabulary and some preliminary steps.

Course performance One major problem in designing P.S.I. courses is designing individual units to represent psychologically equivalent amounts of work. Figure 2 illustrates the ideal case and two theoretical cases in which the ideal design effort has failed. Note that while Figure 1 showed individual progress curves, Figure 2 shows curves averaged over all students. Although individual students may spurt or lag at different times of the semester, the designer of a P.S.I. course expects the average of all students to show a smooth progression from unit to unit.

Figure 2a shows such a smooth progression. Figure 2b illustrates the kind of problem caused by a very hard or long unit. The flat spot in the curve represents an unusually long time for students to complete a single unit. The steady progress of the curve before and after the hard unit shows that the other units in the course are of nearly equal difficulty or are of a level of difficulty easily tolerated by the students. This kind of problem is minor; it may be corrected by reworking the offending unit, perhaps by separating it into two or more new units.

Figure 2cillustrates a more serious problem. Through too much difficulty for all units, or through little motivation of the subject matter, all students delay working on the course at all until the pressures of the terminating semester exert extrinsic motivational effects. The solution to this problem might require complete redesign of the course.

Figure 3 shows comparable curves for the experimental course. Rather than a single summary curve, Figure 3 includes a family of curves showing the class days on which each unit was completed

FIGURE: 2 HYPOTHETICAL PROGRESS CHARTS

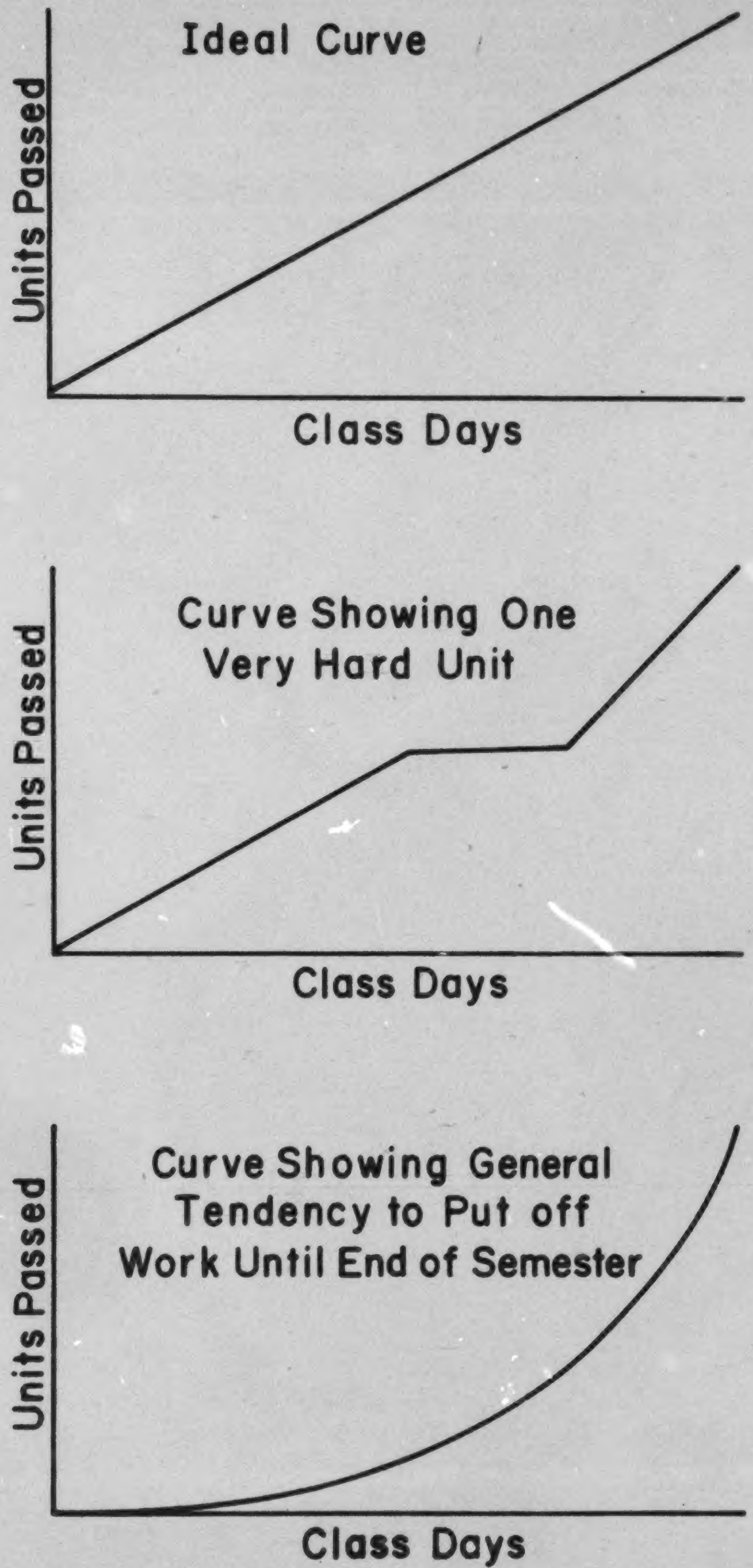
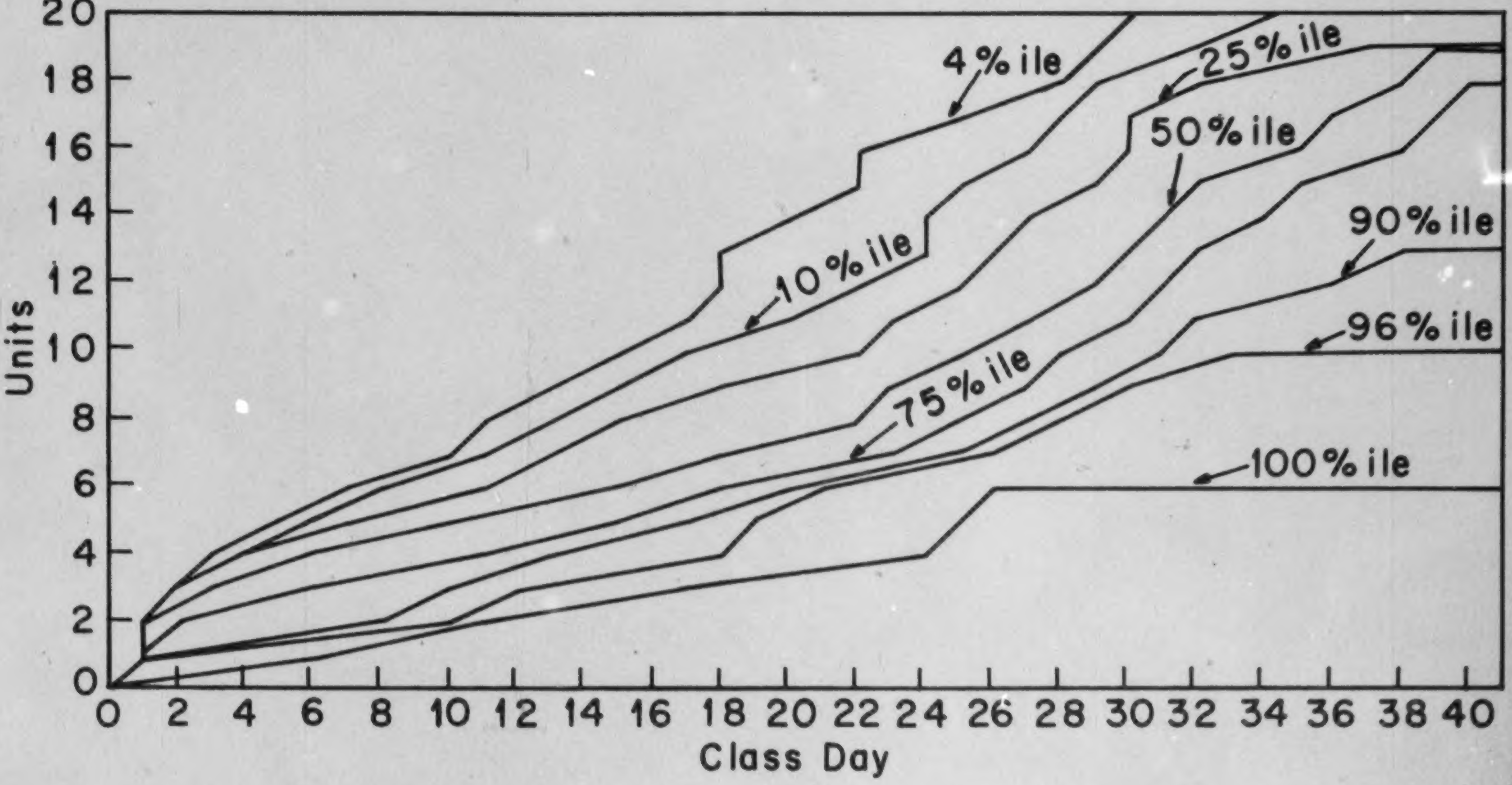


FIGURE: 3 CUMULATIVE PERFORMANCE CURVE FOR STUDENTS
#1,3,7,14,21,25,27 AND 28 (OF 28) IN THE EXPERIMENTAL COURSE



by 1, 3, 7, 14, 21, 25, 27, and 28 students, respectively (the four students who dropped the course are not included in this Figure.)

The curves show almost none of the problems described above. There are no units which consistently show extraordinary time required for passing. Also, there is little indication that work was uniformly postponed until the latter part of the semester.

This second problem is tested statistically in Table 6 for the major percentile curves of Figure 3, i.e., the 25%ile, the 50%ile, the 75%ile, and the 90%ile. By means of analysis of variance procedures, each of those curves is broken into three components:

(1) Linear component, or how much the curve resembles the ideal curve of Figure 2a.

(2) Quadratic component, or how much the curve includes the positively-accelerated feature of Figure 2c.

(3) Residual component -- a measure of how uneven or ragged the curve is.

For all four curves tested in Table 6, the linear (straight-line) component is very large. For three of the curves (50%ile, 75%ile, and 90%ile) the quadratic (end-of-course acceleration) component is also statistically significant. Even so, the component is not large in absolute terms, so the evidence of late-course speed is not a serious criticism. Steady progress throughout predominated, suggesting careful design and good student acceptance and interest.

TABLE 6. TREND ANALYSIS OF FIGURE 3 PERFORMANCE CURVES FOR THE EXPERIMENTAL COURSE

25th percentile

Source	df	MS	F
linear	1	2843.05	865.09**
quadratic	1	7.29	2.22*
residual	17	3.286	

50th percentile

Source	df	MS	F
linear	1	3174.75	1744.97**
quadratic	1	78.12	42.94**
residual	17	1.819	

75th percentile

Source	df	MS	F
linear	1	2549.91	1264.51**
quadratic	1	116.34	57.69**
residual	15	2.017	

90th percentile

Source	df	MS	F
linear	1	1572.66	1544.22**
quadratic	1	24.07	23.64**
residual	10	1.018	

* $p > .10$
** $p < .001$

Student Course Evaluation As part of the course requirements, students filled out extensive (65-item) course evaluations at the time they took their final exams and post-tests. They signed their evaluations but were assured that the instructors would not be shown the results until after the final grades were assigned. (The danger, as perceived by students, is that instructors might intentionally or unintentionally let the student's evaluation, if known, influence the final grade. This possibility is minimized by the P.S.I. format, in which students earned their grades by explicit, step-by-step work; there was no latitude left for an instructor to manipulate grades based on his feelings about the evaluation.) All students seemed to take the evaluation seriously. It was filled out, as part of their final exam, by the 24 students who received final grades by the end of the semester. In order to facilitate analysis of their responses, the items are grouped by similarity of content in Tables 7-12. Discussion of the student evaluations follows:

Approval of P.S.I. (Table 7). Students felt P.S.I. was nonfrustrating, desirable, worthy of repeating at least once, and better than standard courses. They would like to take other history courses similar to this one and prefer that they be taught through P.S.I. They did not miss the normal lectures and felt they had enough student-teacher contact.

TABLE 7. STUDENT EVALUATION OF EXPERIMENTAL COURSE: APPROVAL OF P.S.I.

Items	Answers
4. If given the opportunity, I would take another course taught by this method.	2.33[1]
7. I would like all or most of my required courses to be taught by this or a similar method.	3.33[1]
40. Compared with the other courses I have been taking this semester, I looked forward to the activities of this course.	2.25[2]
46. In general, I consider the P.S.I. method of instruction used in this course to be	1.91[3]
62a. Would you like to learn more about Africa?	23 Yes, 1 Maybe
63a. Would you like to take another history course similar to this but about another geographic area?	16 Y, 3 M, 5 No
63c. If so, would you like it to be a P.S.I. course like this one?	2.0[1]

64a. Would you like to take another history course similar to this in organization but dealing with another topic, theme, or period of history?	18 Y, 1 M, 4 N
64c. If so, would you like it to be a P.S.I. course like this one?	2.14[1]
8. I would like to have had more opportunities for direct contact with my instructor than the method by which this course was taught included.	3.00[1]
9. In my opinion, the method by which this course was taught greatly reduced instructor-student contact.	3.71[1]
10. I would have preferred to have more lectures in this course.	3.04[1]
11. I found it frustrating to have to pace myself through this course.	4.38[1]

Notes:

1. Scored from 1 (definitely yes) to 5 (definitely no)
2. 1 (much more) to 5 (much less).
3. 1 (superior) to 5 (detriment to student).

Specific reactions to general characteristics of P.S.I. (Table 8). Students tended to worry less about their grades, appreciated having unit objectives spelled out, and had less opportunity to interact with other students. Some felt rushed at the end of the semester, but they were balanced out by a group who felt relaxed and unpressured. There tended to be no resentment over failed quizzes, which was reasonable since these 24 students failed a total of only 25 quizzes over the semester. The 14 students who missed one to three quizzes were only slightly more resentful (3.71) than the 10 who failed no quizzes (3.80). To the hypothetical question of why students put off work, most answered outside pressure; only four guessed it would be due to the P.S.I. format.

TABLE 8. DETAILED STUDENT REACTIONS TO P.S.I.

Items	Answers
16. I have felt less worry and concern about my grade in this course than I generally do.	2.50[1]
29. I felt that I had to hurry over large amounts of material toward the end of the semester in order to complete the course.	3.25[1]
31. I usually felt resentful if I did not pass a unit test and was forced to retake it.	3.75[1]
44. In my opinion, the main reason for leaving many units until the end of the semester by some students in a course taught by this method is:	2
45. In this class, the opportunity to interact with other class members was:	3.79[3]
47. I felt that specification of objectives for each unit was beneficial to learning the course material.	1.79[4]

Notes:

1. Scored from 1 (definitely yes) to 5 (definitely no)
2. 16 = much other work; 3 = no class meetings; 1 = decreasing need to compete; 2 = personal problems (multiple choice item).
3. 1 (far greater than usual) to 5 (far less)
4. 1 (always) to 4 (never) to 5 (objectives not specified)

Reactions to details of this course

(Table 9). The reactions were, on the average, quite favorable. Students felt they worked more but learned an appropriate (extra) amount. Texts, audio-visual material, and a novel used in the course were all given high ratings. Students felt quizzes were well-integrated, graded fairly, and at the right level of detail. The only suggestion of a criticism was a mild desire for broader concepts.

TABLE 9. STUDENT REACTIONS TO DETAILS UNIQUE TO EXPERIMENTAL COURSE

Items	Answers
12. I usually understood what was expected of me in this course.	1.79[1]
14. In my opinion, the performance level required for passing unit tests in this course was too high.	3.75[1]
15. In general, I would have preferred more structure (e.g. schedules, deadlines, etc.) than this course included.	4.04[1]
17. It seems to me that too much weight has been assigned to performance on the final examination in this course.	3.25[1]
18. In my opinion, the textbooks and supplementary materials for this course were well-chosen.	2.38[1]
24. This course placed too much emphasis on minor details.	2.96[1]
25. This course placed too much emphasis on broad concepts.	3.75[1]
26. Based on the size of this class, I think we should have had more proctors.	4.17[1]

30. In my opinion, the unit tests were generally well-integrated with the material in the unit.	2.04[1]
32. It seemed to me that the unit tests frequently were composed of what appeared to be minor details rather than major points and procedures contained in the unit.	3.42[1]
33. I felt free to go to my instructor for assistance with problems, if I needed to do so.	1.54[1]
34. The audio-visual materials in this course were effective learning aids.	2.04[1]
35. The audio-visual materials in this course were interesting and motivating.	2.12[1]
36. There should have been less emphasis on audio-visual materials in this course.	3.88[1]
37. The novel read in this course was an effective source of information and ideas.	1.50[1]
38. The novel should either be dropped from the course or replaced by another.	4.38[1]
39. This course should place more emphasis on writing and creative or integrative work.	3.75[1]
41. Compared with the effort I usually put into a course, I believe my effort in this course was:	1.92[2]
48. In my opinion, the material in the study guides for this course generally contained:	2.26[3]
49. Considering the amount of material I feel I learned, the time demands of me by this course seem justified.	2.21[1]

Notes:

1. 1 (definitely yes) to 5 (definitely no)
2. 1 (well above average) to 5 (well below average)
3. 1 (too much) to 3 (enough) to 4 (too little)

Specific reactions (Table 10). Reactions to proctors were uniformly positive. Only five responses(of 168) by four students who had two different proctors were negative, suggesting idiosyncratic patterns in very small proportion.

TABLE 10. SPECIFIC REACTIONS

10a. Reactions to Proctors

Items	Answers[1]
19. The proctors for this course generally seemed to be well-prepared in terms of understanding the content to be covered.	1.50
20. The proctors frequently were able to assist me in understanding aspects of the material which seemed unclear to me.	1.83
21. During the semester, it has been my general observation that the proctors demonstrated patience in their dealings with students in the class.	1.50
22. It often seemed to me that I had to wait an unreasonable long time before my proctor was available to grade my unit tests.	4.62
23. I felt free to disagree with the proctors when I believed I had legitimate grounds for doing so.	1.29
27. I felt free to call on course proctors for help outside class when I was having difficulty.	2.21
28. I usually considered the grading of the unit tests by the proctors to be fair.	1.58

Note:

1. 1 (definitely yes) to 5 (definitely no)

10b. Problem-Solving Knowledge and Attitudes

Items	Answers
51. ...From the list below, identify in order the components of the problem-solving method. ...	0:13; 1:5;[2] 2+: 6
52. Was this problem-solving approach helpful in learning and organizing the material in this course?	2.17[3]
53. Would you use this approach in other situations?	2.42[4]
54.[5] Overall, how satisfied were you with this approach to problem-solving?	2.05[6]

Notes:

2. 0 (errors, i.e., perfect ordering): 13 students, etc.
3. 1 (definitely yes) to 5 (detrimental)
4. 1 (frequently), 2 (often), 3 (sometimes), 4 (rarely), 5 (never)
5. This is a recoding of the actual question to allow numerical scoring.
6. 1 (extremely satisfied) to 5 (extremely dissatisfied)

Question 51, asking for the steps in the problem-solving approach taught in class to be identified in a longer list and then ordered, was a "pop quiz" unanticipated by the students. More than half made no errors. While the rest made errors, most involved substitution or insertion of one or two of the extra steps from the list; the results were still logically ordered sequences. The remaining items (52, 53, and 54) tapped student acceptance of the problem-solving strategy and their willingness to use it. The latter must be taken with a grain of salt, since intentions to employ abstract schemes are followed up only when a clear behavioral chain has been formed. Nevertheless, the students approved of the problem-solving approach taught in the course and stated intentions of applying it in other situations.

Personal benefits and implications (Table 11). Students felt that the course had improved their ability to study and improved their overall efficiency and organization. They perceived themselves slightly more likely to take more history and/or P.S.I. courses and to visit Africa, but their likelihood of becoming history majors was unchanged.

TABLE 11. BENEFITS AND IMPLICATIONS OF THIS COURSE AND P.S.I.

11a. Personal benefits from P.S.I.

Items	Answers[1]
6. I feel that my own general ability to study efficiently has improved as a result of the method by which this course was taught.	1.87
13. The way in which this course was organized and structured allowed me to make more efficient use of my time for other courses and activities.	2.08

11b. Behavioral changes due to this course.

As a direct result of this course, are you more likely to:

Items	Answers
65a. take more history courses?	2.54[2]
65b. take more P.S.I. courses?	2.46[2]
65c. become (or remain) a history major?	2.92[2]
65d. visit Africa?	1.92[2]

Notes:

1. 1 (definitely yes) to 5 (definitely no)
2. 1 (much more likely) to 5 (much less likely)

Semantic differential (Table 12). Several concepts and topics were discussed at length during the course. If students became very familiar with these concepts to the point where they had acquired a clear and consistent meaning such as we might be able to generate for concepts like the American Revolution or the Viet Nam War, then Osgood's Semantic Differential represents a sensitive way of assessing that learned meaning.

TABLE 12. SEMANTIC DIFFERENTIAL REACTIONS TO SEVERAL CONCEPTS[1]

		Eval[2]	Pot[3]	Act[4]
55.	West African kingdoms (before 1500 A.D.)	1.27	1.82	1.17
56.	Colonialism (1800 - present)	-2.13	1.72	1.98
57.	Domestic slavery	-2.99	1.59	1.02
58.	Independent Africa (1960 - present)	1.96	1.02	1.90
59.	Islamic influence	.30	1.78	1.53
60.	Trans-Saharan trade	.05	2.38	1.43
61.	African resistance to colonialism	.96	1.05	1.21

Notes:

1. scaled from -5 to +5
2. based on 4 subscales: kind-cruel, wise-foolish, good-bad, and beautiful-ugly
3. based on 2 subscales: hard-soft, strong-weak
4. based on 3 subscales: active-passive, excitable-calm, and fast-slow

The Semantic Differential is a tool (made up of several adjective-pair Likert scales) for assessing three context-free dimensions of meaning, according to Osgood. The dimensions are abstract, so that virtually anything (from love to sledge hammers) can be meaningfully rated. The dimensions are:

--Evaluation:	the goodness or badness of a concept.
--Potency:	the strength or weakness of something.
--Activity:	the quickness or slowness of something.

For example, puppies might be good, weak, and active and sledge hammers might be neither good nor bad, strong, and passive.

Asking students to rate concepts from this course on the Semantic Differential serves two purposes: it tests whether concepts important to the course have acquired familiarity, meaning, and definition to the students, and it implies that such well-grasped concepts will be retained and utilized by the students in the future.

For the concepts listed in Table 12, results were mixed. Evaluation showed consistent and appropriate values for the different concepts, suggesting that the students liked or admired West African Kingdoms, Independent Africa, and African Resistance of Colonialism and that they disliked Colonialism and Domestic Slavery.

Potency and Activity, however, showed mildly positive, undifferentiated scores across topics. These are more subtle factors than Evaluation, and would be less likely to show consistent results. The negative findings here are not conclusive; the topics may have been taught from a uniformly mildly positive viewpoint, for example. The positive results with Evaluation, however, suggest a good grasp of part of the concepts and a likelihood that the concepts have been understood and permanently learned by the students.

Summary

Thirty-two CMU undergraduates participated in an experimental introductory course on African history taught through a P.S.I. self-paced format. The course was designed to facilitate evaluation of both the course content and the effect of the P.S.I. method. Students provided biographical information and took tests at the start of the semester to test their initial knowledge and at the end of the semester to assess their learning in the two major areas of educational emphasis present in the course: factual and generalized information about African history and broad techniques for formulating and logically solving problems related to historical inquiry. Two control classes, totalling about 30 students, were selected and given the premeasures and postmeasures to provide a stable benchmark against which to measure the effects of the experimental course itself.

Several major findings were developed.

(1) The P.S.I. technique was successful, in terms of student acceptance and enthusiasm and in terms of the demonstrably smooth way that the course unfolded through the test semester.

(2) Students showed significant gains in knowledge of content through the semester; the comparable controls, who were not in the African history course, did not.

(3) Students in the course showed significant increments in their knowledge of broad principles of historical problem-solving approaches, separately and when compared to the control

classes. Finer analysis, however, showed that the learning might be limited to familiarity with the problem-solving vocabulary and its general framework rather than familiarity with and ability to utilize the basic scheme.

(4) Student reaction to the P.S.I. technique, the course content, the instructors, and the proctors was uniformly positive.

Evaluation Summary

Thus, the formal evaluations of the experimental course developed by this project pointed toward at least some tentative answers to the questions guiding the evaluations. These evaluations also pointed up some of the advantages and disadvantages of P.S.I. as an instructional approach. Part II of this report describes and analyzes in detail the project's conclusions about and appraisal of P.S.I. as a mode of self-paced instruction in undergraduate history specifically and in undergraduate education in general. Before turning to this broader analysis, however, attention should be given to specific alterations in the experimental course occasioned by the formal evaluations of the initial course materials.

D. COURSE REVISION

Evaluation of this course served formative as well as summative purposes. In supporting the development of the course the Department of History and Philosophy indicated a desire to offer the course in succeeding years, pending the results of the field trial.

Thus, in order to be prepared for the eventuality that the field trial might suggest a self-paced approach was workable and productive in African history, part of the course evaluation was designed to provide data which would serve as a basis for revising the course for later use.

Information relative to course material, structure and content was gathered in several different ways. An evaluation of each unit -- using a special open-ended questionnaire -- was completed by students selected at random by their proctors. Generally, each student in the course prepared such an evaluation on every third unit. Data relative to the units were also collected by the instructors (1) from interviews with the course proctors who reported their own reactions and suggestions as well as the student reactions and (2) from observations of the students as they worked through the course. In addition, the evaluation of the course prepared by Professor Green provided information relative to the quality of the course structure and materials. The data collected from these sources combined with the student performances on the paper and pencil instruments described above pointed out weaknesses in the course and suggested a number of needed revisions if the course were to be offered again. The final phase of this project was devoted to making these revisions and to preparing new materials so the course could become a regular offering of the CMU Department of History and Philosophy. These revisions were completed during the summer and fall of 1975.

Course Weaknesses and Problems

According to the outside evaluator, proctors, students and course designers, the course exhibited the following weaknesses:

(1) Some students found that the course required too much time to complete for a nine unit (3 semester credit hour) course. Some units contained too many modules. Others required rather lengthy reading assignments. Still other units relied too heavily on books available only on reserve in the university library.

(2) Several units or sequences of units were structurally unclear and appeared to be unrelated to one another.

(3) In some instances, Self-Check tests and unit mastery tests were either "too picky," included questions on data not specified or implied by the unit objectives, or failed to test objectives specified in the unit. In addition, multiple-choice questions appeared to be used to excess while essay questions were limited in number.

(4) There was too little student-to-student interaction in the course.

(5) There was too little opportunity for students to apply the problem-solving model introduced in the course, so that while they could answer questions at the recall or recognition level about this process they could not demonstrate application of the process in a historical context.

(6) The course was a linear course with one unit following irrevocably upon another without options or opportunities for students to pursue their own individual interests.

(7) Specific content areas, deemed crucial to an understanding of African history, received inadequate attention. For example, student performances revealed an inability to understand the chronological sequence of major events, to identify the location in Africa of important historic events or places, and comprehend the basically rural nature of traditional African life -- all crucial to any introductory understanding of the peoples of this part of our world.

Course Revisions

The following revisions, therefore, were designed to eliminate these weaknesses:

(1) Shortening the Course. In order to make this course comparable to other three credit hour courses in demands on student time, the number of modules was reduced from 50 to 45. While the total number of units in the course as revised exceeds by one the number of units (20) in the experimental course, no revised unit consists of more than three modules. As shown in Table 1, units in the revised course average about two modules each. Thus, the course has been shortened both in number of modules per unit and in total number of modules.

Table 13

Number of Modules in Course

Unit Number		Modules in Experimental Course	Modules in Revised Course
Experimental	Revised		
1	1	1	1
2	2	2	1
-	3	-	2
3	4	2	2
4	5	4	3
-	6	-	2
-	7	-	1
5	-	3	-
6	8	4	3
7	-	3	-
8	9	2	2
-	10	-	2
9	11	3	2
10	12	4	3
11	13	3	3
12	14	3	3
13	15	2	2
14	16	2	2
15	17	2	2
16	18	2	2
17	19	3	3
18	20	2	2
19	-	1	-
20	21	2	2

In addition, the average length of the course modules (as defined by the number of pages of assigned reading) was reduced considerably. Since the field trial indicated most students could handle about 20-25 pages of reading in an hour to an hour and a half, most module assignments were reduced to this number of pages. To reduce the time involved in trying to secure books from the library fewer reserve books were assigned. However, in the future three, rather than two, books will be used as course texts by the students; most reading assignments will be from these texts. Module Self-Checks were also redesigned to require a maximum of about 20-25 minutes each. Thus, an average revised unit consisting of two modules should now require about 4 to 4 1/2 hours of student study -- 1 to 2 hours per module for study and self-testing and about 45 minutes for the unit test and proctor meeting. A third module adds about two hours to a unit.

(2) Restructuring selected units. In order to sharpen certain concepts, emphasize certain generalizations or focus more precisely on certain skills some units were dropped, new units written and other units modified. For example, Units V (The Origins of African Peoples), VII (Other African States) and XIX (Application - Doing African History) were dropped altogether to make room for new, more important units. Unit II was expanded by one module and split into two separate units. Unit IV (Studying Africa's Past) was reduced in length and a new unit devoted exclusively to the introduction of a problem-solving model in African history was added. Other new units include a unit giving students an opportunity to apply the problem-solving model to a specific topic in African history and a unit built around a novel to introduce a concept of cultural interaction and change. Both the trade (Unit X) and slave trade (Unit XI) units were shortened and tightened conceptually. The entire final third of the course was reorganized so students could test a hypothesis about the impact of the colonial experience on Africa. Review units and the final unit were completely rewritten to reflect changes in the preceding course materials. New introductions were written for several units, and new materials and activities were added to other units. Table 13 above indicates the restructuring of the course in terms of changes in the distribution and total number of modules.

Eliminating all four-module units should enhance student motivation -- no more "massive" units will be encountered. In addition, reducing the length of Units I-V should ease students into the course without overwhelming them with long units. Units that follow reviews (IX and XIV) remain shorter in order to encourage students to move along; units in the final third of the course remain shorter than earlier units because, as Professor Lilly V. Koen has pointed out, students tend to underestimate what can be done in the time remaining to them as a semester draws to a close; thus, when they encounter only two-module units they have a better chance of completing these units because the units are shorter than they expect. Furthermore since experience shows that "the word" that the final units are shorter than earlier units is quickly passed by students who first complete these units, students should be encouraged to move ahead more rapidly and/or willingly.

(3) Revising tests. In order to remedy the weaknesses in the course tests, (1) Self-Checks and Unit Tests were revised to include more open-ended questions and fewer multiple-choice questions, (2) test items were rewritten to correspond more directly to specific unit objectives and (3) test items that proved invalid or unreliable were either rewritten or dropped. In addition, more essay questions were included. Essays are now introduced earlier in the course and used more frequently, becoming longer and more sophisticated as the course progresses. Essay questions move from requiring descriptions to requiring explanations, analysis, synthesis and evaluation. A new form of problem-solving essay question has been added to require students to engage in a problem-solving process. Finally, to bring variety to

the testing procedure and to develop communication skills, an increased number of proctor interviews and group discussions were substituted for paper and pencil module and unit tests.

(4) Providing opportunities for student interaction. Although students seemed to enjoy the opportunity to move through the course without being held up by slower students or overwhelmed by faster students, many seemed to miss opportunities to interact with other students. Therefore, in the revision more opportunities were created for (1) paired learning experiences -- especially in the early part of the course (as in Unit III) when students still cluster on the unit, (2) student-proctor interviews as Self-Checks, (3) student-student discussions and/or interviews as Self-Checks, and (4) class discussions (in Units I, VII and X). Group and paired activities decline as the revised course progresses and students become strung out across a greater number of units thus diminishing the number of opportunities for such group work.

The decision to build in class discussion requires additional comment. Class discussion seems useful in the early stages of the course, especially if this course is the first course of its type students will likely take. Periodic class discussions can ease the transition from lecture-discussion courses to more independent study in the early units of the course. These discussions can serve also to motivate student learning. In the case of this particular course, the discussion techniques will also provide students an opportunity to use the problem-solving model introduced in the course by engaging them in a problem-solving activity. This activity will also give the instructor an opportunity to diagnose and remedy student deficiencies in the application of this model to historical problems. Thus, group discussion becomes an important part of the first half of the revised course, but it gives way to student-student and then student-proctor interviews as the students move through the course and become spread out further across more units. Two-thirds of the way through the course students will thus find themselves moving independently, without reliance on others for reinforcement or assistance.

(5) Improving the problem-solving component. Results of the evaluation indicated that while students could, as a result of this course, talk about the general steps of a problem-solving strategy and could use several problem-solving skills in isolation, most did not employ these strategies and skills when given a history assignment in which there was an opportunity or need to do so. Such inability or reluctance may have been due to the few opportunities provided by the course to apply the strategy presented in the course as well as a lack of attention to refining and applying basic problem-solving skills throughout the final third of the course. Thus, a number of revisions were made to remedy these two deficiencies.

First, Unit IV, Studying Africa's Past, which introduced the problem-solving model and selected skills, was divided into two units with the second unit expanded to require students to apply the strategy to a particular problem. Self-Checks in both units were improved. The Unit tests for these units were also redesigned to require further application of these skills.

Second, a new unit, VII, Solving a Problem in African History, was written to offer students an opportunity to apply this problem-solving process in the context of the course. This unit has two special features. First, it is a "floating unit," one that may be done independent of other units and/or simultaneous with them if students prefer. However, this unit must be completed by Unit XV, a review unit, where it is also tested. The second unique feature of this unit lies in the nature of the unit test. Unlike other units in the course, the test for this unit involves a group discussion in which five or more students meet with the instructor to report and critique the results of their problem-solving and then analyze the process they employed to reach their solution. The discussion class also offers an opportunity to engage in another problem-solving activity if the need arises. Floating units such as this allow students to move ahead through other units in the course while waiting for enough fellow students to complete the unit so a discussion group can be scheduled. Thus, at least in the early stages.of the course, group learning is built into an essentially independent study structure without violating the self-pacing principle.

A third way in which the course has been revised to facilitate problem-solving learning has been to provide more opportunities in later units of the course to apply problem-solving techniques. Thus, problem-solving questions have been added to a number of unit mastery tests culminating in a major test question in Unit XVIII.

Finally, more emphasis has been placed on problem-solving in the final third of the course. This segment has been restructured to pose a problem for investigation in Unit XVI which requires students to use succeeding units to solve the problem and gives them an opportunity to report their conclusion in the final unit of the course. In addition, this part of the course as revised now gives students more opportunities to use the skills of problem-solving to identify problems from data, to brainstorm hypotheses, to extrapolate evidence, to gather and analyze this evidence and to evaluate this evidence and their hypotheses against given criteria and against self-devised criteria.

(6) Providing more options for student inquiry. As originally structured, this course required all students to move through the same units in sequence without skipping any units. However, such a procedure, while essential to the development of skills and certain substantive concepts or generalizations, apparently failed to meet individual interests or needs. Hence, in order to individualize the course, the floating unit described above was devised. If, in subsequent trials this technique works, additional units can be revised as floating units. Two other types of units, best described as a "self-defined" unit of study and as an "in-depth" study of a specific topic related to the major unit topic can be spun off required units to individualize study still further. Whether or not such units will work awaits trial of the new floating unit as the revised course is used.

(7) Making specific changes in course content and materials. In order to clarify basic concepts and information, changes were made in various materials and the ways in which certain information was presented. Basic to all these changes was a decision to use three basic texts, instead of two as in the experimental course, and to cut by half the number of readings in reserve books.

The initial filmstrip/recording was revised to include emphasis on rural life styles, a point underemphasized in the original presentation. Additional map work was designed as the core of a revised third unit and maps were inserted more frequently into materials to be used throughout the course. Greater attention has also been paid in the unit introduction, directions and self-checks to the sequence and interrelations of events in Africa's past.

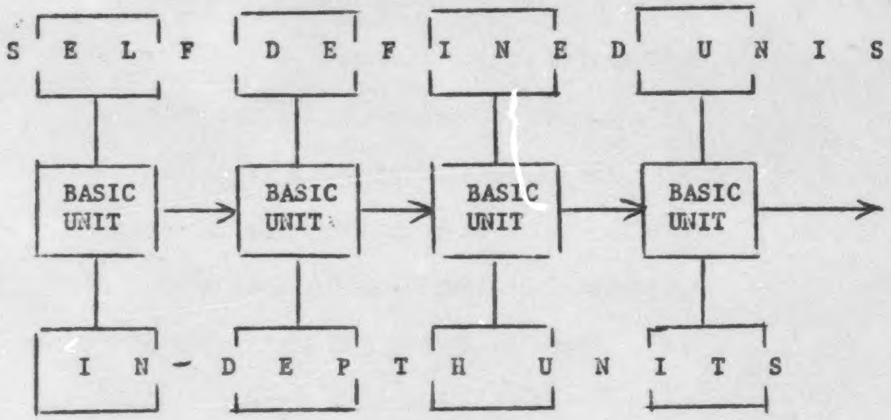
In addition to the above revisions made in the course, the field trial and the staff evaluation suggests future consideration of still other changes. These possible changes include:

(1) offering a diagnostic test at the beginning of each unit in order (i) for students to appraise their strengths and weaknesses regarding the unit topic and thus set some objectives of their own for unit study, (ii) to motivate students, and (iii) to permit those who have already mastered the material in the unit to skip the unit and move on to new units.

(2) adding more self-defined units in which students select topics, questions or problems of interest to them for further study or investigation. Such units may be similar to the "floating unit" added to the revised course or to more open units based on specific topics, general areas of study or historiographic problems.

(3) developing a completely new structure for self-paced courses in which there is a core of required or basic units through which all

students move but from each of which students have two options -- (i) to explore a special in-depth unit related to the basic unit topic and/or (ii) to define for study a topic of their own related to the basic unit topic. Such a structure may be diagrammatically represented as:



Thus, in a course consisting of 10 basic or core units each having two optional units, students might be required to complete a total of 20 units for complete course credit. Variations on this structure appear to be numerous and of considerable potential for individualizing instruction far beyond the limits inherent in P.S.I. as presently used.

(4) Designing questions, topics and activities requiring students to engage in more relational

> thinking and to manipulate or analyze more than two variables simultaneously. In this way higher level analytical skills may be further developed. In addition, more attention to identifying patterns in events, variables or conditions may also help students improve their skills of logical analysis.

These and other revisions may still further improve this or any self-paced course in history for CMU undergraduates. However, such changes require considerable time to design and should be thoroughly tested. An effort to do this might be a worthwhile extension of this present project.

PART II - CONCLUSIONS AND IMPLICATIONS: P.S.I. AS A FORM OF SELF-PACED INSTRUCTION

What happened as a result of this project? At least two things of significance. First, Carnegie-Mellon University now has certain instructional assets that did not exist prior to this study: (1) an operational, tested, undergraduate, self-paced course in history built on the basic principles of P.S.I.; (2) an H&SS faculty member with some practical experience in and knowledge of developing and using P.S.I. in undergraduate history teaching; (3) additional informal interdisciplinary links between the history and psychology departments and between the College of Humanities and Social Sciences and the self-paced instruction group in Carnegie Institute of Technology; (4) an informal link between history department faculty and the C-Map staff counseling students enrolled in undergraduate history courses; (5) awareness on the part of other faculty in the College of Humanities and Social Sciences of the attributes of self-paced learning as an instructional alternative; and (6) a formalized effort within the history department and within the entire Doctor of Arts program to inform and, to some degree, train doctoral candidates in the essentials of self-paced learning.

The training of doctoral candidates -- and indirectly, of faculty -- in self-paced learning requires further elaboration. By actively participating in this project as part of his history doctoral program, Mr. Thomas O'Toole acquired invaluable experience in the mechanics of this approach to self-paced learning. At the request of his administration, upon his return to Western Carolina University, he plans to introduce a form of self-paced learning into that institution's history program. In addition, thirteen history graduate students were introduced in depth to P.S.I. as an instructional technique in their Internship in Curriculum Development in History (79-879) taught by Dr. Beyer during the Spring 1975 semester. Two history doctoral candidates, Lawrence Rivers and Ronald Zarychta, and undergraduate history major John McGuire, served as proctors in the field trial of the course and in so doing became thoroughly familiar with P.S.I. Mr. Rivers plans as a doctoral dissertation to test an adaptation of P.S.I. to an introductory undergraduate history course in Afro-American history. Mr. McGuire entered the CMU history M. A. program in the Fall to pursue further study in the teaching of history. Plans now call for expansion of these doctoral training efforts to include all CMU Doctor of Arts candidates through the new D.A. core course in Instructional Design initiated in the Fall 1975 semester.

In addition to the above instructional efforts, a less formal effort has informed faculty within H&SS about self-paced learning in general and about P.S.I. in particular. During the Spring 1975 semester, the history department devoted one of its regular informal colloquia to a report of the nature and results of this project to apply P.S.I. to undergraduate history. A number of English department faculty attended this meeting which consequently led to an exploration of the application of self-paced learning to undergraduate instruction in English, the social sciences and humanities in general. Thus, this study has produced a number of specific benefits for the university, for a number of its history graduate students and a number of its H&SS faculty.

The second important result of this study consists of what was learned about P.S.I.-based self-paced instruction, not only in terms of its specific applicability to undergraduate instruction in history but even more broadly to its applicability to undergraduate instruction in general. One major product originally planned as an outcome of this project was to have been a set of guidelines for faculty interested in implementing self-paced instruction. Such guidelines already exist, however, at least in terms of practical suggestions on how to organize a self-paced course using the Personalized System of Instruction approach.[21] What is lacking is an appraisal of the apparent strengths and weaknesses of this instructional technology. Such an appraisal would enable faculty interested in self-pacing to evaluate the appropriateness of this particular approach for their students and themselves and to become aware of the limitations of this method and of some possible ways for dealing with these limitations.

The study undertaken in this project has pointed up -- in some cases, dramatically -- (1) the disadvantages as well as the advantages of P.S.I. for students, faculty and educational institutions alike; (2) some adaptations and changes that seem advisable to make P.S.I. work well in undergraduate history teaching, and (3) further research that seems crucial before P.S.I.-based, self-paced learning can be adopted to any great extent by CMU or other comparable institutions of higher education. Hence, this part of the report

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21. See David G. Born, Instructor Manual for Development of a Personalized Instruction Course (Salt Lake City: Center to Improve Learning and Instruction, University of Utah, 1971 rev ed.) and Procter Manual (Salt Lake City: Center to Improve Learning and Instruction, University of Utah, 1971 rev. ed.); Fred S. Keller and J. Gilmour Sherman, The Keller Plan Handbook (Menlo Park: W. A. Benjamin, Inc., 1974) esp. pp. 24-49; and David T. Tuma, A Guide to Conducting a Self-Paced Learning Course (Pittsburgh: Carnegie Institute of Technology, undated), unpublished paper.

details the project; conclusions about the applicability of P.S.I. as a form of self-paced instruction in undergraduate history and then presents an analysis of this instructional approach based on a review of the research and the experience of this project. The observations made here should be most useful to any educators considering the use of P.S.I. or self-paced instruction in their curricula.

A. TENTATIVE CONCLUSIONS ABOUT P.S.I. AS AN APPROACH TO UNDERGRADUATE HISTORY TEACHING

This project set out to answer four specific questions about the utility and value of independent, self-paced learning in undergraduate history courses at CMU. Obviously this study alone cannot provide definitive answers to these questions. Nevertheless, the project did produce evidence and experience which can suggest at least tentative answers to these questions, especially in terms of the P.S.I. type of self-paced learning. Tentative responses to three of these questions follow.

1. P.S.I. based self-paced learning in history can be done for college undergraduates. This study indicates clearly that P.S.I., in its original form (as devised by its originators), is workable in undergraduate history teaching. It is possible to state virtually all types of generally accepted history objectives clearly and in behavioral terms, to structure a course in the form of written study guides, to provide immediate testing and feedback via proctors, to permit students to move through a course at their own rate of speed, to insist on mastery learning, and to present lecture/demonstrations as occasional offerings. In terms of its mechanics, P.S.I. works in an undergraduate history course -- and, it can be inferred, will work in any undergraduate course in any similar discipline.

This study also suggests that proctors are the key to a successful P.S.I.-based self-paced course. Proctors monitor tests, provide immediate feedback, discuss problems and sometimes tutor their students. They serve as intermediaries between the students and the course as presented through the study guides and tests and appear to be on the side of the students, working with them to master the course. Humane, responsible, flexible and sensitive proctors make a P.S.I. course successful. Irresponsible, rigid, know-it-alls can destroy a P.S.I. course.

Proctors can be drawn from any number of sources -- from graduate students studying in the field of the course or completely new to the course topic, from undergraduates who took the course previously, and/or from among the most advanced students in the course itself -- for peers may make the best of all types of proctors. And proctors may be rewarded with course credits, or stipends, hourly wages, or assistantships. Many students reportedly also serve voluntarily as proctors. But regardless of where they come from, what training they have or what their rewards, proctors do prove indispensible to a P.S.I. course.

It should be noted, however, that proctors may be a mixed blessing to some extent. Although many students come to them for help, not all do. Faster students sometimes see proctors and proctor interviews as obstacles to their progress and do what they can to avoid talking with them. Slower students often use proctors as a crutch, relying on their prompting, encouragement and help to move through the course. Although proctors do enable an instructor to personalize and individualize the course to a greater extent than is possible in most conventionally taught courses, proctors tend to insulate the students from the instructor. Proctors also place a new demand on instructor's time because it is necessary for the instructor to meet regularly with them to tutor them through the study guides and unit tests. Hence, while proctors are an important part of a P.S.I. course, they do seem to create some problems in some instances.

Even though P.S.I. works mechanically as a form of self-paced learning for history undergraduates, one part of this instructional system does not seem to work as intended. This project demonstrates, as have other similar research studies, that the occasional large group lecture/demonstrations do not serve as the motivators they are intended to be.[22] Although fourteen students were eligible to attend the first lecture, only six did in fact attend; only five of an eligible seventeen attended the second lecture.[23] Although students who attended these lectures rated them very highly -- indeed, thought they were outstanding -- no evidence exists that these lecture/demonstrations had any impact whatsoever on student progress in the course.

Moreover, some evidence exists to suggest that the special lectures may have had a negative impact on students in the course. Once word about the high quality of these lectures got around, proctors and instructors detected a note of disappointment and frustration among students who had been ineligible to attend or who had been eligible but for one reason or another had failed to attend these

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22. For summary of lectures, see Appendix H.

23. Although 14 of the 23 eligible students attended the third lecture, inclusion of this "lecture" has been omitted from this discussion because the "lecture" was built around an African meal which in itself may have been the prime attraction, given the nature of urban, undergraduate college living in these times.

lectures. Even though the second and third lectures were delayed a week each from their originally announced times to permit more students to qualify, the attendance rate did not improve and a number of students did complain about being "locked out."

In sum, the principle of lectures as motivators did not seem to work. Only about a third to a half of the eligible students attended; only about a third to a half of the students in the course were eligible. Apparently a lecture with admission requirements is not a sufficient attraction to motivate students to move through the course at the schedule determined by the instructor.

As in most other studies of P.S.I., the results of this study suggest that special lectures with requirements for admission be dropped. Instead, such lectures could be open to all students in the class regardless of where they are in the course or they could be required of all students in the class. Such lectures could also be put on tape and made integral parts of the course by serving as the core of or introduction to a specified unit. To allow for individual self-pacing such units could be designed as floating units, permitting students to complete these units when ready while continuing to move through the regular units as they wish.

The use of a variety of reading materials can also limit the effectiveness of P.S.I. Most successful P.S.I. courses -- in math, engineering, physics and other similar courses -- appear to be built around one or two basic texts which the students purchase and to which they have ready access. However, a P.S.I. course which requires students to utilize a large number of sources in addition to a general text, is likely to create problems for students regarding access to these materials, unless copies can somehow be made available to each student. Duplicating other sources is not only expensive but also involves copyright problems. Placing sources on reserve in a library or other study room limits student opportunities to use them to the times these places are open; having less materials than the number of students merely compounds the problem of access on demand. Requiring students to use a large number of sources not available to them at all times seriously compromises the self-paced feature of P.S.I. Thus, for courses which rely on the use of reserved books, as many history courses do, P.S.I. may not be the best form of self-paced instruction. On the other hand, if ways can be devised to circumvent this problem, then P.S.I. will work reasonably well.

2. P.S.I.-based self-paced instruction enhances learning in undergraduate history courses. Secondly, the results of this study indicate that P.S.I.-based instruction in history produces readily definable student learning in history as measured by instructor appraisal of student interest and motivation, by student performance on final exams, and by the students' own testimony. Because this study lacked any carefully-defined control group as a basis of comparison such a judgment as this must remain for the moment rather subjective and tentative. Yet when compared to control groups, students in the experimental course learned a significant amount of information and skills as a result of study in this course. The research provided no evidence whatsoever to contradict the general findings of other research on P.S.I. that reports students learn as much or more than students in conventionally taught courses on the same subject.

3. P.S.I. instruction in history appeals to many college undergraduates. The results of this study suggest that certain types of students appear to like P.S.I. as an instructional approach more so than do other types of students. P.S.I. seems to appeal to at least two different types of students. First, this instructional approach appeals to students who are not majors in the subject area and who want to have as much freedom as possible in taking the course. In many instances, these students want "to get it over with as soon as possible" in order to concentrate on semester-end projects in their majors. P.S.I. offers these students an opportunity to do just this while still demanding a mastery level of performance.

Secondly, P.S.I. courses seem to appeal to students of middle or lower ability levels -- students who might draw C's in conventional courses due to their failure to attend lectures, disinterest, heavy reliance on others to carry them through or simply willingness to do just enough work to "pull a C." P.S.I. courses motivate these students to "outperform themselves." The opportunity to earn an A without having to compete against the most able students serves to motivate these students; their success on unit tests breeds higher interest and self-esteem; this interest and increased confidence in themselves leads to increased motivation and learning; and so it goes. Of all the types of students that could enroll in a course, this type seems to benefit the most from and most like a P.S.I. course -- at least in history.

B. SOME ADVANTAGES AND DISADVANTAGES OF P.S.I.

A fourth question with which this project dealt concerned the advantages and disadvantages of P.S.I. as a form of self-paced instruction in undergraduate education. Like other instructional approaches P.S.I., too, has its strengths and weaknesses for students, faculty and educational institutions alike. Many of these features have already been presented and analyzed in the research literature.[24] This project has not only highlighted these but has pointed up what appear to be additional advantages and disadvantages that deserve attention.

However, two cautions seem to be in order before discussing the advantages and disadvantages of P.S.I. Available research on P.S.I., while approaching mountainous proportions, seems to be of varying quality. Much of this research consists of impressionistic observations by classroom instructors or the results of student interviews and evaluations; some research offers no comparable control groups as a basis for comparison. Much research is based on P.S.I. classes enrolling only a small number (8-20) students. Many of the instructional approaches tested under the P.S.I. ruberick fail to include the essential features of P.S.I. or drastically modify one or more features -- perhaps most frequently the self-paced feature which is often modified by all sorts of techniques to deal with the so-called problem of "procrastination." Research on P.S.I. must be evaluated with these limitations in mind.

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24. See, for example, Kulik, P.S.I.: A Formative Evaluation; Bruce A. Ryan, P.S.I.--Keller's Personalized System of Instruction: An Appraisal (Washington: American Psychological Association, Inc., 1974); Robert S. Ruskin, The Personalized System of Instruction: An Educational Alternative (Washington: American Association for Higher Education, 1974); Donald A. Cook, Personalized System of Instruction: Potential and Problems (EPIE Report #61); Sherman, 41 Germinal Papers.

Furthermore, while P.S.I. is a form of self-pacing, not all self-paced instruction is P.S.I. Instructional programs do exist in which students proceed at their own individual rates without unit mastery, proctor interviews, detailed written study guides or the use of lectures for motivational purposes only. Tutorials and independent reading courses, for example, both seem to be generally self-paced in nature. What makes P.S.I. a unique form of self-pacing is the presence of these four features just noted. Because these features when combined with self-pacing seem to enhance student learning significantly, P.S.I. does lend itself to serious consideration and special study as a viable form of self-paced instruction.

However, it must be obvious that P.S.I. is not and never was intended to be the only way to teach. P.S.I. is not a panacea for all the ills that plague undergraduate or even pre-collegiate education. On the contrary, P.S.I. exists as one instructional approach that effectively speaks to certain specific teaching-learning problems. It must be used in judicious combination with other modes of instruction to achieve its maximum effectiveness. It seems reasonable to think that a department or curriculum should use large-group lectures, small group discussions, seminars and self-paced learning not only for the sake of variety but also to meet the needs of individual students and to facilitate the great variety of learning objectives which it seeks to accomplish. P.S.I. can be one of many useful teaching-learning approaches. Any appraisal of P.S.I. must keep these two cautions in mind.

What, then, are some advantages and disadvantages of P.S.I.?

For Students For students, P.S.I.-based self-paced instruction offers many advantages as well as disadvantages. The most significant advantages as highlighted by this project and other research include the following:

(1) P.S.I. improves student learning. In self-paced instruction built on the principles of P.S.I., students learn more (in terms of amount retained at the end of a course as measured by a "final exam"), retain more information longer (as measured by an exam some months after a course has concluded) and transfer their learning to other courses where they tend to do better (as measured by grades in these courses) than non-P.S.I. students.[25]

(2) P.S.I. motivates students to learn. The opportunity to earn an A by successfully mastering given material which appears to have no hidden agenda (due to the explicitly stated learning objectives and precise directions) -- rather than trying to outguess an instructor -- appears to be most attractive to students and especially to those students who might in a more traditional class have to struggle merely to earn a C. Such an approach reduces grade pressures and also motivates students to move through the course. The opportunity to move at one's own pace and not be held back or pulled along by others also serves to motivate learning. So, too, does the realization that the course matches the student against him/herself rather than against other students.

(3) P.S.I. seems to move students from trying to outguess the instructor and to please him or her, to making some minimal

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25. Kulik, P.S.I.--A Formative Evaluation, pp. 3-5.

engagement with the subject matter through the medium of the study guide (although in fact the study guide is the instructor and students find themselves trying to outguess study guides -- information -- rather than people).

(4) P.S.I. gives students an opportunity to move at their own individual paces and to set their own schedules. Thus, students who face major projects near the end of a semester can step up their paces to complete a P.S.I. course early rather than try to do both at once and perhaps thus risk doing poorly in both. In the same way students can move into and out of the course without penalty as other demands on their time warrant.

(5) In P.S.I. courses, students feel less threatened by the instructor even though the instructor via the study guide is still in control of the course. The removal of this arbitrary control seems to lead to a more relaxed learning situation.

(6) P.S.I. offers immediate personalized feedback which provides positive reinforcement for most students and thus increases their motivation to complete the course. The opportunity to develop a one-to-one relationship with a proctor who would help them "beat the course" seems to be most attractive to many students.

(7) P.S.I. promotes extra-class individual and group interaction in dorms, the library and the classroom and stimulates students to assist each other -- and to share insights and information.

(8) P.S.I. offers a new instructional approach -- some variety, which in itself is a welcome element in learning for many students. Such an instructional approach also appeals to some students turned off by required lectures or small class discussions.

(9) Finally, P.S.I. courses offer an excellent training ground for any students planning teaching careers whether these be at the college, community college or secondary levels. Serving as a proctor provides an excellent opportunity for internships in teaching and learning, for the one-to-one contact with students offers excellent insights into processes of learning and facilitating learning. In a P.S.I.-based course the students taking the course are only one product -- the proctors working in the course not only learn the subject matter but also learn about learning and teaching at a practical, individual level, and thus become a second product of the course.

As attractive as P.S.I. courses may appear to students, however, these courses do have some drawbacks. P.S.I.-based self-paced courses seem to present the following disadvantages for students:

(1) P.S.I. courses, as some students do not hesitate to point out, "are hard work." Most students indicate they work harder in P.S.I. courses -- study longer, review more frequently, read more -- than in most conventional courses. In fact, many students seem to overstudy especially for unit tests and interviews, spending more time than is generally necessary for mastery. One reason for this may be the fact that in a P.S.I. course, each student is obviously on his or her own and cannot float through on the coat tails of a neighbor or smarter classmate. Performance on a unit test is up to the individual and thus students must study to perform well. Students may also perceive P.S.I. courses as requiring harder work because completing a unit study guide requires concentrated study of an intense nature in contrast to a general reading of a multi-paged assignment in a conventional course. Thus, the intensity of their study in P.S.I. may

lead students to feel they "work harder" even though the time actually spent is equal to or less than that spent in studying for conventional courses.

(2) P.S.I. courses rely heavily on writing as the major means of communication. Thus, students who have difficulty reading may suffer as a result. Although this may not be a major problem for most college students, reading (in terms of speed, level of comprehension, etc.) may be a problem for certain types of college students such as culturally disadvantaged or foreign-born students. Emphasis on the written word may also pose a problem for vocationally-oriented students in certain types of two or four year colleges that emphasize technical rather than academic education.

(3) P.S.I. may also restrict student-initiated inquiry and student-directed learning. Pre-made study guides that direct students exclusively along lines determined by the instructor do not usually permit students to follow their own interests. Yet, in some courses student defined guides can be developed within a P.S.I. format.

(4) P.S.I. may also decrease student-to-student interaction, especially in small group or discussion class settings. For many students this is no disadvantage. But for some who seem to learn well in discussion settings, the absence of such group activities and emphasis on individual-content interaction (except at the proctoring stage) may prove to be a decided handicap. The use of proctors, especially peer proctors,[26/] can alleviate some of this difficulty. Development of specific P.S.I. group activities as described above can also deal with this problem.[27/]

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26. C. B. Ferster, "Individualized Instruction in a Large Introductory Psychology College Course," in Sherman, 41 Germinal Papers, p. 189.

27. See above, pp. 71-72

(5) P.S.I. courses often create a time problem for many students which reveals itself in a sometimes unusually high drop-out rate or in a form of behavior that some researchers label "procrastination." Whereas self-pacing may be viewed as an advantage in that it permits students to move at their own rates according to their own abilities, interests and other commitments, self-pacing also requires that students plan their study by setting reasonable time goals or deadlines and by meeting these deadlines. However, many students do not seem to be able to do this and fail to complete units or courses within what the instructor or institution considers to be a reasonable time. A good number of undergraduates cannot pace themselves!

Ideally, there could be no procrastination in self-pacing. However, certain features of educational institutions (i.e. semesters or quarters, faculty and student loads, etc.) make time a factor in learning. Thus, while P.S.I. seems to remove the instructor as a threat to students, it substitutes time itself. For students who do not complete a P.S.I. course "on time" -- by the end of the semester or quarter -- all types of problems arise, including the problems of final grades (incomplete or failure?), and of extra work in the following semester when the P.S.I. course must be completed on top of a full load of regular classes.

Some P.S.I. instructors employ a number of techniques designed to reduce student procrastination and to ensure movement through the course. These techniques include the use of devices such as progress charts which indicate where students should be if they are to complete the course at a given time or certain "doomsday" deadlines and check points -- "all students must complete Unit 4 by February 1 or drop the course." -- or required tests at a given date on specific units or repeated proctor encouragement to move along or proctor contact of laggards. More subtle devices also have been used, such as getting the course off to a quick start with several short, quickly done, interesting units; varying the length of units so that a series of short, "snappy" units appear just about the time students are slowing down, thus encouraging them to move along.

For Faculty The role of faculty in P.S.I.-based, self-paced courses differs somewhat from their role in more conventional instruction. However, the differences are not as dramatic as they appear at first sight. In a traditional lecture course, the instructor serves basically as a designer of lectures, dispenser of knowledge, designer of tests and evaluator of student achievement. All of these functions also remain typical tasks of an instructor who teaches a P.S.I.-type course -- only the communications medium changes.

In lecture-discussion or in smaller seminar or class discussion types of courses, student-student and student-faculty interaction increases considerably. Here the instructor's role broadens to include guiding learning by careful questioning techniques, spontaneously building on student responses and generally facilitating the development of insights into the problem or topic under study. All of these functions remain part of an instructor's role in P.S.I., but seem to be modified somewhat by added functions, changed emphasis and the use of written guides as the major faculty-student means of communication.

From a faculty member's point of view, P.S.I. seems to differ most from conventional teaching by removing the instructor from personally and verbally passing on information and directing the learning process as discussion leader, lecturer or questioner. Instead, these basic teaching functions are carried out in P.S.I. courses through written study guides which question, dispense knowledge, and test and through proctors who question again and often build on student responses to develop new insights. The instructor directs the learning process through the study guide which serves in effect as an extension of the instructor. Use of this device actually frees instructors to do more to influence learning than they otherwise could do, for in P.S.I. courses the instructor is free to spend class time not in lecturing or leading discussions but often in working with individual students or small groups of students who have indicated a need for assistance or additional information.

Thus, the emphasis on certain instructional functions changes in P.S.I. courses and with this change comes a redistribution of instructional time. As in conventional courses P.S.I. instructors still find themselves dispensers of knowledge but usually through study guides rather than through lectures.[28/] They find themselves also serving as course designers, but spend time writing study guides rather than preparing lectures. They make tests -- many more than ever before and often quite different from tests to which they are

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28. P.S.I. courses thus do not eliminate lectures. Such courses merely put them in different formats. In some P.S.I. courses, faculty lectures are put on tapes for student use on demand. In other instances, "lectures" are often written into unit study guides as extended introductions or directions. In still other instances faculty write lectures as essays and assign them as readings.

accustomed. They ask questions -- usually in the study guides and often in individual or small group tutoring sessions. Thus, even though what an instructor does in a P.S.I. course with, to or for students may appear to differ dramatically from what an instructor does in more conventional teaching, P.S.I. does not alter the basic teaching functions. This approach merely gives different emphasis to different functions and requires that these functions be carried on in places (individual "tutoring" in regular class time rather than outside of class) or times that differ from more conventional teaching. P.S.I., in effect, extends the instructor as a teacher by means of study guides and proctors.

What P.S.I. does require that may be different from what conventional lecture or discussion teaching requires, is careful and detailed advanced planning of the course. The instructor must break the course into "chunks" that students can master and organize these "chunks" into a conceptual structure that enhances learning. In so doing the instructor must select and state clear learning objectives, design and sequence learning experiences -- questions, readings, activities, and devise specific evaluative techniques or questions that measure student achievement of the objectives. These efforts often require much more attention to course planning than many instructors are wont to give. P.S.I. makes it impossible for an instructor to "wing it" with last year's notes or a glib tongue -- and survive!

Consequently, faculty find that P.S.I.-based courses, at least in history, offer both advantages and disadvantages as far as they are concerned. Among the advantages for faculty are the following, in no particular order of importance:

(1) P.S.I. leaves a record and because it does, this enables instructors to diagnose student learning difficulties much more readily than they can in conventional instruction. Such a record also enables an instructor to identify weaknesses in the course — confusing questions, inappropriate readings, irrelevant activities, poor test items — and thus improve the course as it proceeds.

(2) P.S.I. creates a teacher-student relationship different from that typical of conventional teaching. In P.S.I. courses instructors appear as learning facilitators rather than as founts of all knowledge. This is a fine but very significant distinction. Students in P.S.I. courses actively seek out instructors for help in mastering the course objectives, if they have contact with the instructors at all. Instructors are readily available in regular class times for individual assistance, a situation which dramatizes this new role. Students thus often view the instructors as helpers rather than as hindrances to "getting through the course" — even though the study guides that constitute the course really serve in loco instructor!

(3) P.S.I. gives instructors an opportunity to know more individual students better than they could know in conventional instructional systems.

(4) P.S.I. sharpens teaching. Creating study guides that communicate clear and concise learning objectives, essential information, directions and test items forces faculty to weed out trivia, to clearly identify the most desirable learning objectives, to structure learning experiences carefully, to pose clear questions and to design tests that relate to the unit objectives — clearly earmarks of effective teaching. Any instructor who conscientiously designs and

tries a P.S.I.-based course cannot help but emerge from the experience a better teacher by any set of criteria.

(5) P.S.I. makes instructors more sensitive to student abilities and interests and to the great differences in these abilities and interests. Unlike large lecture courses where an instructor faces a nameless mass of students, P.S.I. instructors deal with students on an individual basis and, as they do, become increasingly alert to them as unique individuals -- something best reflected in revisions of their course materials as their courses progress.

(6) P.S.I., like any other teaching, can assuage the ego. Faculty can derive as much or more satisfaction from seeing their P.S.I. course work as they can from that inner feeling of having given a good lecture (whether anyone listened or not) or asked some searching questions, or having led an exciting class discussion in which perhaps a third of the class took an active role.

Yet P.S.I. self-paced courses present numerous disadvantages for faculty. Foremost among these disadvantages are the following:

(1) P.S.I. courses produce increased paper work and record keeping in the form of student progress charts, unit tests and retests, completed study guides and so forth for each student. Without proctors and/or course managers, dealing with this paper work would be impossible for a single instructor teaching more than 20-30 students.

(2) P.S.I. courses require considerable instructor time in planning, designing and preparing the course. In addition, P.S.I. courses require additional instructor time in meeting weekly with proctors and in being present at each class session. Instructors who conduct P.S.I. courses may spend more time in work related in

these courses than they would spend in conducting or preparing for more conventionally-taught courses, at least the first several times through the course.

(3) P.S.I., as normally practiced, limits opportunities for instructors to capitalize on or guide spontaneous learning that is often generated in group discussions or regular class settings. For instructors who derive ego satisfaction from "being in command" of this type of learning, P.S.I. appears to be a decidedly inadequate instructional approach.

(4) P.S.I. courses restrict opportunities for instructors to engage with students in a verbal interaction in which they can communicate enthusiasm, excitement and vitality that can (i) turn kids on to the subject at hand, (ii) generate new insights and intellectual growth on the part of the instructor as well as the student, (iii) capitalize on student interests and spontaneous remarks or questions, and (iv) stimulate the instructor as well. The absence of such opportunities in basic-P.S.I. courses may restrict the intellectual growth of the instructor and it may frustrate instructors who derive personal satisfaction from dispensing knowledge, being the center of a learning situation or receiving student attention. Although effectively written and organized study guides can remedy this situation to a large degree (writing can communicate enthusiasm and excitement, study guides can be written to capitalize on student interests or build on student insights, and guides can be built to involve instructors with small groups of students), the absence of faculty-student verbal interaction in regular classroom environments may be viewed as a serious drawback of P.S.I. by some faculty.

For Educational Institutions P.S.I.-based courses or self-paced instruction in general also offer a number of advantages to educational institutions while at the same time present a number of problems for these institutions which may be considered serious disadvantages. The following appear to be among some of the more significant institutional advantages of P.S.I. self-paced learning:

(1) P.S.I. improves instruction and, hence, learning. Creation and use of P.S.I. courses makes faculty more conscious of and responsive to student abilities, interests and differences, more conscious of communications problems, more precise and better organized in planning and executing instruction -- especially in testing and evaluating and brings them closer to individual students. Such instruction also offers unparallelled opportunities to handle diverse groups of students whether this diversity be in student skills or student interests or other student characteristics. Self-paced learning offers the potential for improved quality of instruction and attention to teaching which is one important factor which attracts students to colleges.

(2) P.S.I. serves as a replacement for or partial tool for use in the impersonal, large introductory lecture courses offered by most departments. In fact, P.S.I.-based self-paced learning may be the presently "missing link" between teacher-directed learning typical of secondary schools and self-directed learning typical of upper division undergraduate education and graduate education. If self-directed learning is a legitimate goal or requirement of college education, self-paced study using a P.S.I. format offers an easy introduction and transition to it. Thus, self-paced learning adapted for large

freshman/sophomore courses may serve two useful purposes -- to personalize the large course and enhance student learning, self-esteem and interest in the specific discipline, and to ease students into the techniques of self-directed learning essential to success in later years of college.

(3) P.S.I. seems to facilitate skill development and may especially facilitate the development of problem-solving skills and processes. This approach seems ideally suited to any type of course in which learning must be cumulative and sequential.

(4) P.S.I. self-paced learning permits more objective diagnosis of instruction, both for purposes of improving teaching and of evaluating teaching. P.S.I. courses constitute publications which can be examined by others for scholarship. These courses also constitute records of teaching which, in conjunction with student performance and student evaluation, can be examined for pedagogy. P.S.I. may thus expose poor (in terms of student satisfaction, performance on tests) teaching. Trying to design an acceptable P.S.I. course frustrates poor teachers and reveals their inabilities or inadequacies. And in this same way P.S.I. reveals good teaching!

(5) P.S.I.-based self-paced learning offers probably the least expensive way to educational improvement available today. For example, P.S.I. requires no hardware whatsoever -- no computers, no teaching machines, no expensive extra equipment. P.S.I. courses rely solely on the printed page as media of instruction. Of course, P.S.I. courses can use film, audio tapes and other more expensive equipment just as can other types of courses, but this equipment is not essential for the successes of P.S.I.

Moreover, P.S.I. type courses offer the possibility of increasing faculty productivity in at least four ways. By improving teaching, P.S.I. leads to improved student learning and motivation. P.S.I. also enables an institution to offer a wider variety of courses where small enrollments may make regularly scheduled classes uneconomical or impractical. P.S.I. may also enable individual faculty to teach more than the number of students taught by conventional methods thus enabling institutions to reduce the number of faculty needed to teach certain types of courses and/or to schedule more time for faculty research, thus improving scholarly productivity as well.

(6) P.S.I. enables an institution to offer courses for a variety of student populations that may not be able to regularly attend classes on a campus or other central location. Extension or in-service courses for people in education, business and industry may find this approach particularly useful. Courses for senior citizens or people confined to medical, retirement or penal institutions may also find it useful. Use of P.S.I. as a basis for independent study or readings courses for individual students seems obvious. Thus, P.S.I.-based courses increase the potential student audience for an institution.

(7) P.S.I. can "turn students on" to a subject and by so doing enhances their self-esteem. Research suggests that achievement breeds self-esteem and P.S.I. offers students a chance to succeed.[29] Students who meet with success in a P.S.I. course may identify not only with the method but also with the subject in which the method

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29. Benjamin Bloom, "Affective Consequences of School Achievement," in Block, ed., Mastery Learning, pp. 13-28.

is employed. Thus, a successful learning experience in P.S.I. history can create interest in and a liking for a particular discipline, as in this case history.

P.S.I.-based self-paced instruction also presents certain unique problems to institutions. The following disadvantages seem most crucial:

(1) The initial start-up costs can be high. One faculty worked quarter-time and a research assistant worked half-time during the entire Fall 1974 semester to prepare the course developed by this project. They continued developing materials until early Spring. The research suggests any faculty member developing a P.S.I. course be released half-time the semester preceding the offering of the course to create the course structure, study guides, tests and materials.[30] This seems to be the minimum time necessary to develop a viable course -- if the instructor has some knowledge of test construction, question asking and objective writing. For those unfamiliar with these skills, longer time or some technical assistance will be required.

(2) Grading often presents a problem in P.S.I. courses. The literature on P.S.I. abounds with discussions of whether or not grades should be related to the number of units of a P.S.I. course completed by a given time or based on some type of point system based on units completed and extra work undertaken. Much of the rationale for these grading systems are philosophical and will not be debated or even presented here. Suffice it to note that in this study students

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[30] Green, "Fifteen Reasons," in Sherman, 41 Germinal Papers, p. 118; J. Gilmour Sherman, "Logistics," in Fred S. Keller and J. Gilmour Sherman, P.S.I.--The Keller Plan Handbook (Menlo Park: W. A. Benjamin, Inc., 1974), pp. 48-49.

were instructed that they must complete the course at the mastery level and when they did they would receive A's. Such a policy seems perfectly realistic in terms of the basic principles of self-paced, mastery learning. Institutions which see grades as a way of categorizing students for other purposes, however, may find this grading system inadequate. Establishing an alternative may prove quite difficult.

A more practical problem relating to grading may also arise. What happens when a student does not complete a course before the end of a grading period? Can an Incomplete grade be given? How long can Incompletes be held? What problems does giving an Incomplete create for central record-keeping? Ideally, a student who fails to complete a course before the end of a quarter or semester would receive an I and the grade would be changed whenever the course is completed. But too many I's may tax the resources of the central administration and cause confusion in transcripts and other records.

(3) P.S.I. threatens the security of faculty. If self-paced instruction is viewed as a way to eliminate faculty, successful implementation of this approach may never occur; faculty unionization or professional activism may increase; and any potential educational benefits from this motivation may be destroyed. P.S.I. can be a real threat to faculty security and hence faculty-administration reactions need careful attention by any administration interested in introducing P.S.I.-type courses into a curriculum.

In sum, P.S.I.-based self-paced learning enhances teaching and learning, brings variety to educational programs, helps an institution meet the needs of and thus attract a variety of diverse individuals and groups, personalizes instruction in large lecture courses, increases the number of courses available for students, facilitates the development of basic skills, and bridges the gap between teacher-directed and self-directed learning. In P.S.I. students engage directly with the content of the course rather than with an individual. On the other hand, P.S.I. courses require a great deal of faculty and student work, take considerable time to prepare, require adjustment to new teacher-roles, and pose a number of problems regarding grading, scheduling, and faculty management.

C. LIMITATIONS OF P.S.I. - APPEARANCES AND REALITIES

Obviously, not all the strengths and weaknesses of P.S.I. as an instructional approach in undergraduate education have been delimited here. Certainly, some features of P.S.I. that would appear to be advantages for a specific discipline or institution or type of student might work to the disadvantage of another discipline, institution or type of student. Such a judgment must be made with caution, however, In some instances the limitations of P.S.I. are more imagined than real.

For example, P.S.I. in its current, popular form does not individualize instruction as much as it appears to do so nor as much as it may seem advisable to some faculty or students. Neither does P.S.I. seem to offer much opportunity for student-to-student interaction. P.S.I. courses seem to focus on teaching isolated facts and low-level cognitive knowledge while neglecting higher level skills, knowledge and affective objectives. If these traits were indeed characteristic of P.S.I. they alone would be enough to recommend against its use. However, such traits are not inherent in P.S.I. and where they exist they reflect more the limitations of the course designers than flaws within the system itself. Analysis of these apparent limitations may help clarify this point.

P.S.I. seems, on the surface at least, to be a form of "individualized instruction." And in a sense, it is individualized more than conventional large group lecturing or small group discussion courses in that P.S.I. permits a student to move at his or her own rate of speed and offers opportunities for individual tutoring when requested. Yet P.S.I., as originally conceived, is discipline rather than student-oriented. This instructional approach seems to say: "Here is a body of knowledge (i.e. skills, facts, concepts, generalizations) to master. Take your time. Get whatever help you need. But, master it!" Little if any attention is given to varieties of learning styles, use of different learning routes to the same objective, or use of materials appropriate to different ability levels. Nor does P.S.I. in its original form permit students to follow their own interests, to be truly independent learners.

This is not to say, however, that P.S.I. cannot be individualized more than it tends to be. By offering diagnostic tests preceding a unit or module students can be given an opportunity to skip units which they have, in effect, already mastered, or at least set their own learning goals for areas in which they evidence a lack of mastery. By providing units in which students can select their own topics, choose from a variety of media geared to different interests and ability levels and/or generate their own questions, P.S.I.-based self-paced courses may be even more individualized than most tend presently to be.

Because of its attention to individual self-pacing, P.S.I. appears to make opportunities for student-to-student interaction in groups rather difficult. Emphasis on individual testing and proctoring and on each individual moving at his or her own rate of speed seems to prevent any kind of group work at all. Whereas possibilities of group interaction may exist early in a course when most students are bunched up on the same units, these possibilities decrease as individual students proceed to get strung out across a large number of units as the course progresses.

Yet opportunities for group interaction do exist within the P.S.I. structure without violating either the mastery or self-pacing principles. Just as student-student interviews can be arranged, so can group-instructor or group-proctor interviews be conducted. In some units students can work with partners instead of working alone. Moreover, floating units culminating in small group discussions (such as the units designed for the revised version of the course developed in this project) may provide opportunities for student-to-student discussions without impairing the rate of progress through the course of any individual student.

Small group, student-student interaction may also become part of a P.S.I. course in two additional ways. First, learning activities or modules built around audio or visual media can be arranged to encourage students to participate in small groups. Such is quite likely to happen in practice regardless of the instructor's plans. In this study, students often spontaneously used audio-visual materials in group situations -- and such groups usually included several students who had just finished using the same materials and were anxious to share their new insights with their peers. Students also voluntarily arrange small groups in the course of their out-of-classroom study. As the course develops, students sometimes get together in the library, dorms, or other gathering places to discuss or work on units or to help each other complete Self-Checks or remedy deficiencies revealed by an inability to complete a Self-Check. Thus, although P.S.I. strictly adhered to may mitigate against small group interaction, in practice much voluntary grouping does occur and structures like the floating unit or activities such as audio-visual modules can be deliberately devised to require such learning experiences.

P.S.I. courses often overemphasize fact-learning and lower level cognitive skill development to the exclusion of higher level cognitive knowledge, skills and affective dimensions. This situation may result from the designer's concentration on writing the behaviorally stated objectives and very precise, well-ordered directions or study questions called for by some P.S.I. practicioners. Factual knowledge objectives lend themselves to such precisely stated objectives and questions whereas higher order objectives usually require more effort to specify and delimit. In the rush to write a useful study guide marked by clarity and precision, authors may go the easy route and deal with what seems to be done best -- concentrating on factual knowledge. Considerable alertness to this tendency is required if the more complex skills of intellectual analysis, synthesis and evaluation are to be employed and developed in P.S.I. courses and especially if affective objectives such as cultural empathy or historical-mindedness are to be developed.

Similarly, preoccupation with precisely stated objectives and questions and emphasis on factual knowledge often distracts from efforts to help students improve their skills of written communication. Most model P.S.I. tests seem to be multiple-choice or short-answer completion or single statement tests. Yet, especially in history and related disciplines, students need numerous opportunities to practice and improve their writing skills by preparing short essays. Specific attention must be paid to writing activities if students are to develop communication skills in P.S.I. courses.

Calling attention to the fact that P.S.I. seems to limit individualization, group interaction, attention to higher cognitive and affective objectives and development of writing skills, does not mean that P.S.I. inherently prevents or denies accomplishment of these objectives. Quite the contrary. These features may be built into P.S.I.-based courses. But to do so, one needs to be aware of the fact that P.S.I. is structured in such a way that an instructor bent on following its basic principles is likely to overlook opportunities to accomplish these objectives within the popular P.S.I. format. Thus, special attention needs to be given to these four areas of instruction if one wishes to incorporate them in a self-paced course built on the principles of P.S.I.

D. SUGGESTIONS FOR FOLLOWUP RESEARCH AND DEVELOPMENT

Needed Research in Self-Paced Learning As noted above much research on P.S.I.-based self-paced learning is impressionistic or incomplete. Additional research will have to be conducted before this type of instruction can or will become widely used. Three types of carefully designed and evaluated research seem imperative:

(1) Research which measures against carefully matched control groups and in as objective fashion as possible the amount, type, retention and transfer of learning that results from P.S.I.-based courses and the degree to which this learning surpasses, matches, or fails to equal learning in conventional large group and/or discussion courses.

(2) Research that identifies the key elements of P.S.I. Research already suggests and this study confirms that in P.S.I. occasional lectures or demonstrations do not seem to motivate learning, hence we know with some degree of certainty one part of P.S.I. that may not work and certainly is not essential. Some research also suggests that mastery requirements and self-pacing seem to be important ingredients of P.S.I. But which of the remaining elements of P.S.I. are the essential elements seems as yet uncertain.

To what extent, for example, do students succeed in P.S.I. courses because of extensive proctor tutoring or encouragement instead of other factors? Proctors appear to be a key to P.S.I. courses. But which kinds of proctors work best? Students seem to like having proctors but this may be because they have never related to an instructor in a non-threatening situation or because proctors are easy to con. The role of proctors in self-paced courses needs closer examination than it so far has received. Research is needed to evaluate all the different combinations of P.S.I. features in order to find those that are basic to learning through this approach.

(3) Research that investigates various questions relating to P.S.I.-based instruction, such as:

(a) What is the best type of study guide? How detailed should a guide be? Should guides near the end of a course differ from those at the beginning? What is the ideal length of a unit? Should guides state objectives or not? - questions? ~~intro~~ductions? Should objectives be stated in terms of observable student behavior?

(b) What types of tests work best? Does putting questions from previous unit tests on new unit tests bias the final results? Does the type of test item affect the results? Should diagnostic tests be given at the beginning of each unit?

(c) To what extent do lectures and large group presentations with prerequisites have a negative effect on students who do not quality for attendance?

(d) To what extent does a P.S.I. course succeed because of the Hawthorne effect?

(e) Do students in P.S.I. classes learn more, retain it longer and transfer learning better than students in small group discussion courses?

(f) Can courses be partly conventional and partly P.S.I.?

(g) Should the first P.S.I. course experience differ from P.S.I. courses students may encounter in upper division undergraduate education?

(h) Are peer proctors better than graduate student or faculty proctors? Are proctors necessary at all?

(i) What kinds of students do best in P.S.I.-based self-paced courses? Do culturally disadvantaged or academically less talented students succeed better in P.S.I. courses than in other types of courses? Why? Do non-majors -- who may care only for a quick run through a course without getting deeply into the discipline or course -- succeed as well or better than majors in a P.S.I. course?

(j) What kinds of strategies do students devise to succeed in P.S.I.-based courses? Do students limit their study only to stated objectives or specific questions? Do students take unit tests without much study in order to "see what the unit really wants?" Do students use study guides?

(k) Can students be weened from external reinforcement and rewards (such as guaranteed A's or self-pacing or praise) and immediate feedback to internal reinforcements and delayed feedback?

(l) Does P.S.I. work in higher division courses where higher levels of knowledge and affective objectives constitute major learning goals?

(m) Can P.S.I. courses develop student verbal and/or writing skills better than conventional courses?

(n) Can P.S.I. courses teach problem-solving?

(o) Do P.S.I. courses which use one-to-one student-proctor interviews produce better learning than P.S.I. courses that use class or group discussions with the instructor instead?

Recommended Followup to this Project P.S.I. or other types of self-paced instruction warrant further trial and research in undergraduate education particularly in large introductory and lower division undergraduate courses and in history, the humanities and the various social and behavioral sciences. Self-paced learning techniques also warrant exploration at the community college and secondary school levels. The following types of followup to this study therefore seem most desirable:

(1) A major research study applying modified P.S.I.-based self-paced study to a basic freshman history course. This study should develop and test a self-paced course to parallel an existing course and then use this course to measure the extent, type, retention and transfer of learning in comparison with the same course conventionally taught. A major research study such as this will enable researchers to deal with a number of areas listed as areas for needed research and to determine to some extent the truly essential features of self-paced study.

(2) Initiation of a staff development program to train graduate students and faculty in various departments to develop P.S.I.-type self-paced courses. Such a program should involve studies of relevant research and application of this research to specific courses. Faculty can thus receive help in designing their own self-paced courses. Graduate students can receive training that will enable them also to design similar courses for institutions where they may later secure positions. In the meantime the university will have a cadre of discipline specialists trained to help faculty develop self-paced courses. If this program were to be offered

through the Carnegie-Mellon Education Center, this Center could provide a most useful service to the CMU faculty.

(3) Revision and expansion of the Tuma guidelines for developing a self-paced learning course with distribution of these guidelines to all departments. Many faculty at CMU have already experimented with P.S.I. and have a wealth of experience to offer novices. This experience should be formalized and communicated to other faculty via an enlarged guide and perhaps by periodic seminars and colloquia.

(4) Development of a major project to field test P.S.I. units in various disciplines in community colleges. P.S.I.-based self-paced study seems to speak directly to the needs of most community colleges where students with inadequate skills and poor motivation abound, where students have various demands on their time that prevent or inhibit regular class attendance, where all types of students -- from youngsters trying to decide on a vocation to older adults deadly serious about improving their education or professional status to senior citizens interested in broadening their knowledge -- often can be found in the same course. Initiation of such a project by CMU could establish CMU as a leader in educational improvement at the post-secondary levels.

(5) Development of a major project to design and field test self-paced instruction in the final years of secondary school education. The junior and senior years of secondary schooling offer a logical place to help students begin to move from teacher-directed to self-directed learning in preparation for study in institutions of higher education or for life in society. P.S.I.-type courses offer

one way to make this transition. Such courses can be devised for academic subjects and for special community-related studies, career education and social action courses. The problems of decreasing motivation at the junior-senior levels of high school and of "nothing to do" can also be addressed by P.S.I. courses. Initiation of a project of this nature can continue CMU's already strong position as a leader in secondary school educational innovation.

(6) Continued research to explore useful adaptations of P.S.I. to humanities and social science courses at the college level and to develop models for self-paced instruction that will facilitate development of higher order cognitive knowledge and affective objectives. New formats involving small group discussions while maintaining the principles of mastery and self-pacing must be developed if P.S.I. is to be useful at all levels of higher education. Thus, a project to conduct research and development in these areas seems most desirable.

In sum, P.S.I. is a viable form of individualized instruction albeit with problems yet to be completely resolved. This instructional approach seems to be applicable to undergraduate study in history and similar types of courses. A significant proportion of students find P.S.I. courses useful and attractive. As a mode of collegiate instruction in history and the humanities, P.S.I. warrants serious attention.